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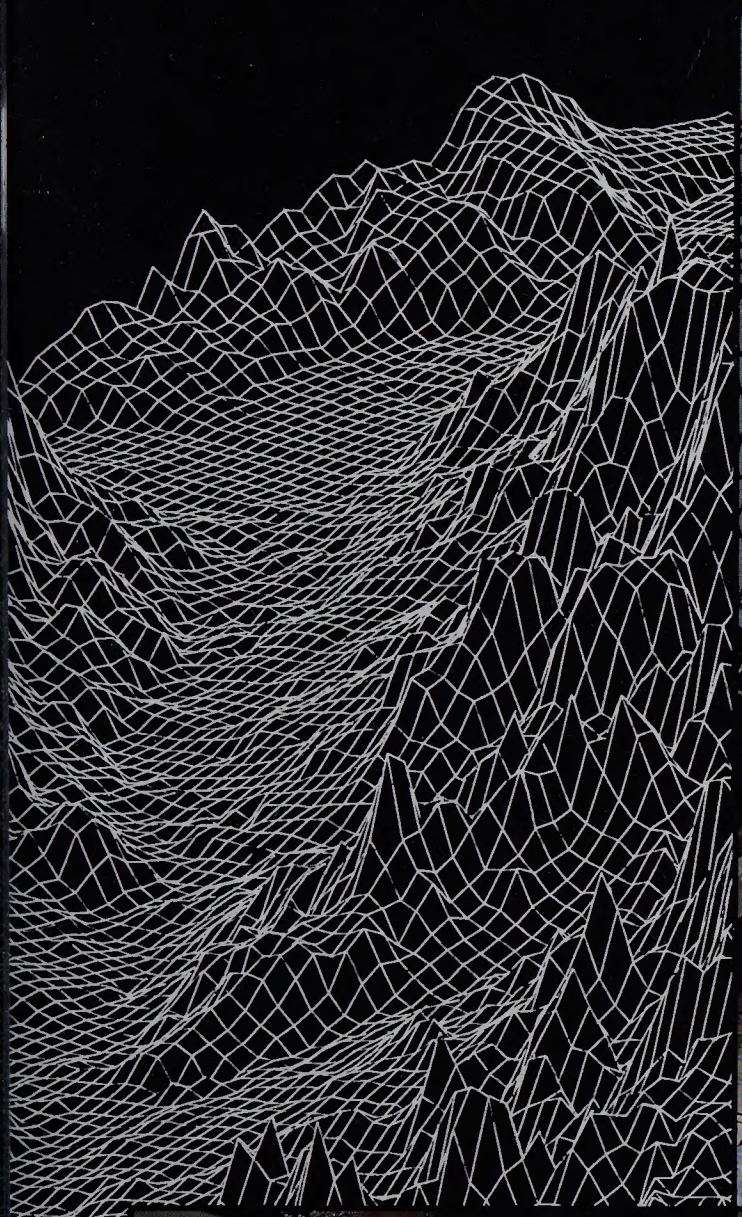
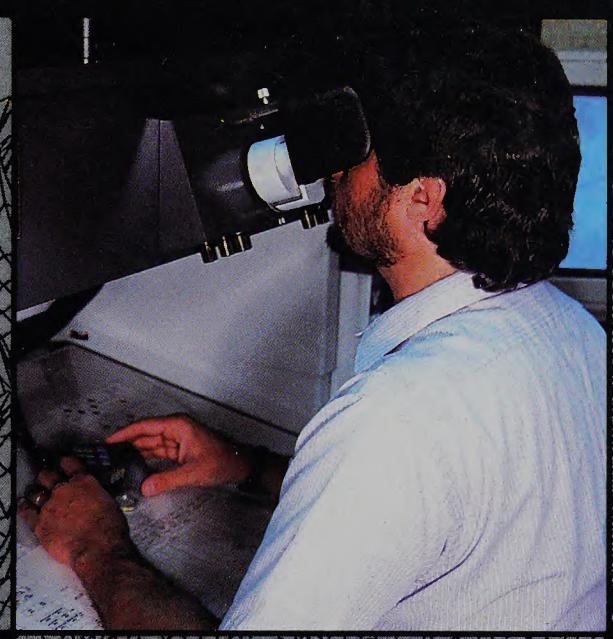
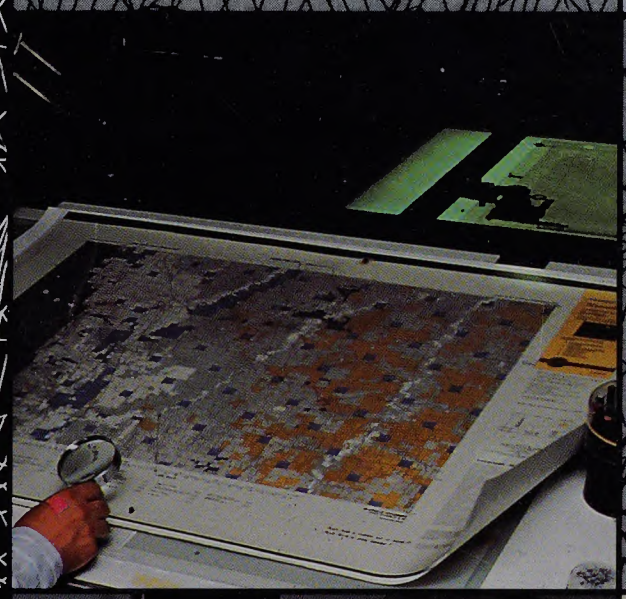
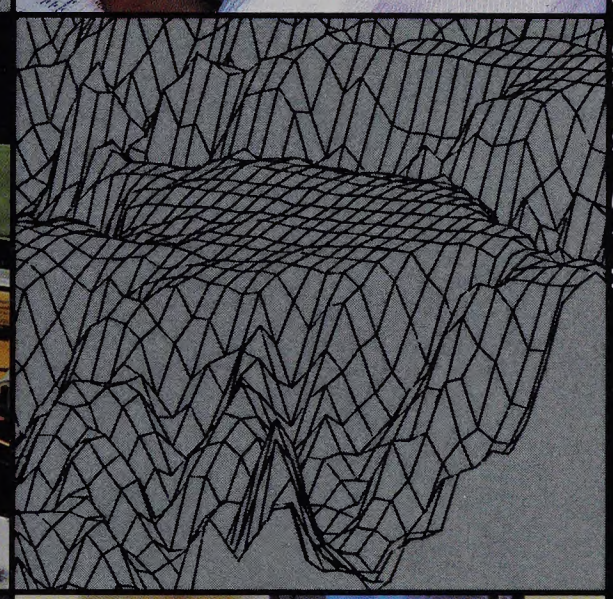
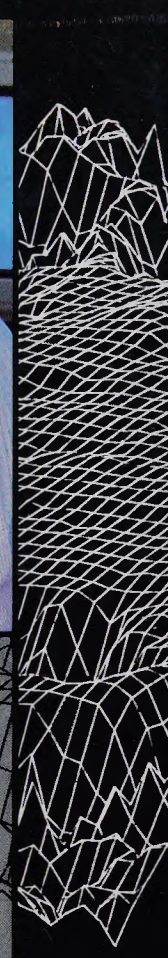
Resource Mapping Support Study for the BLM's Land Information System

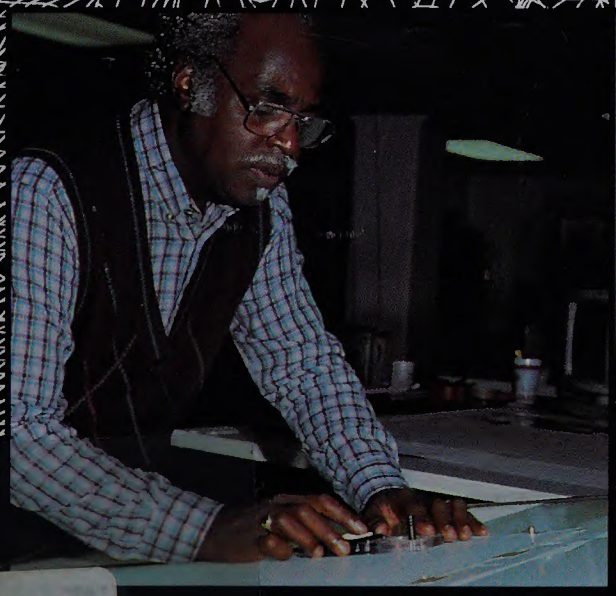


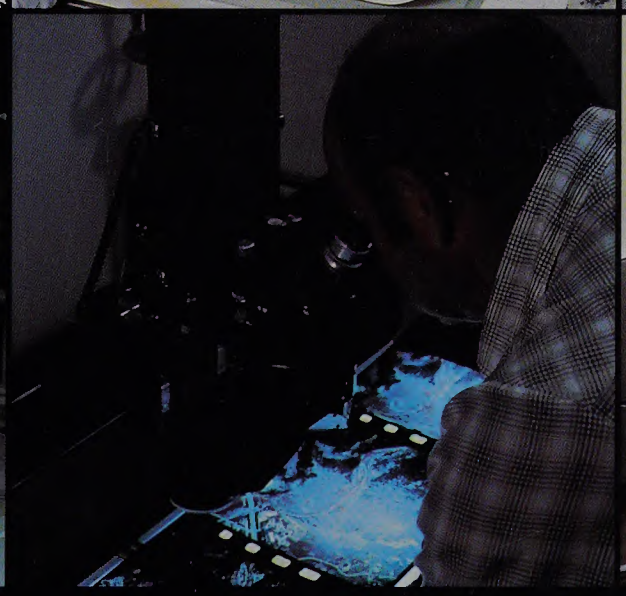


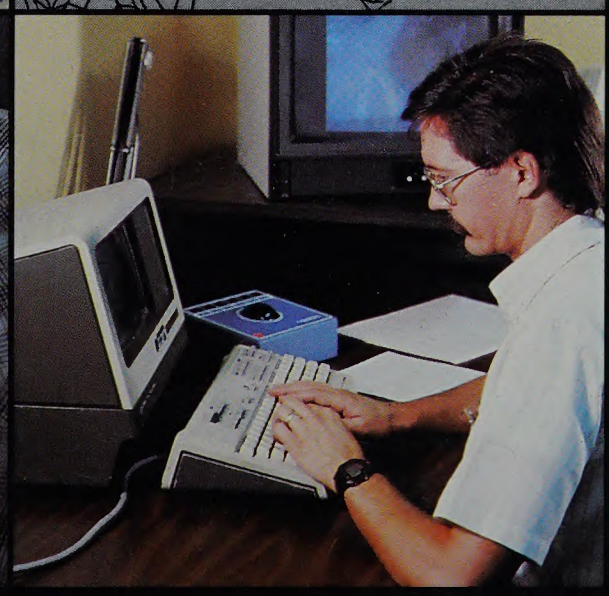












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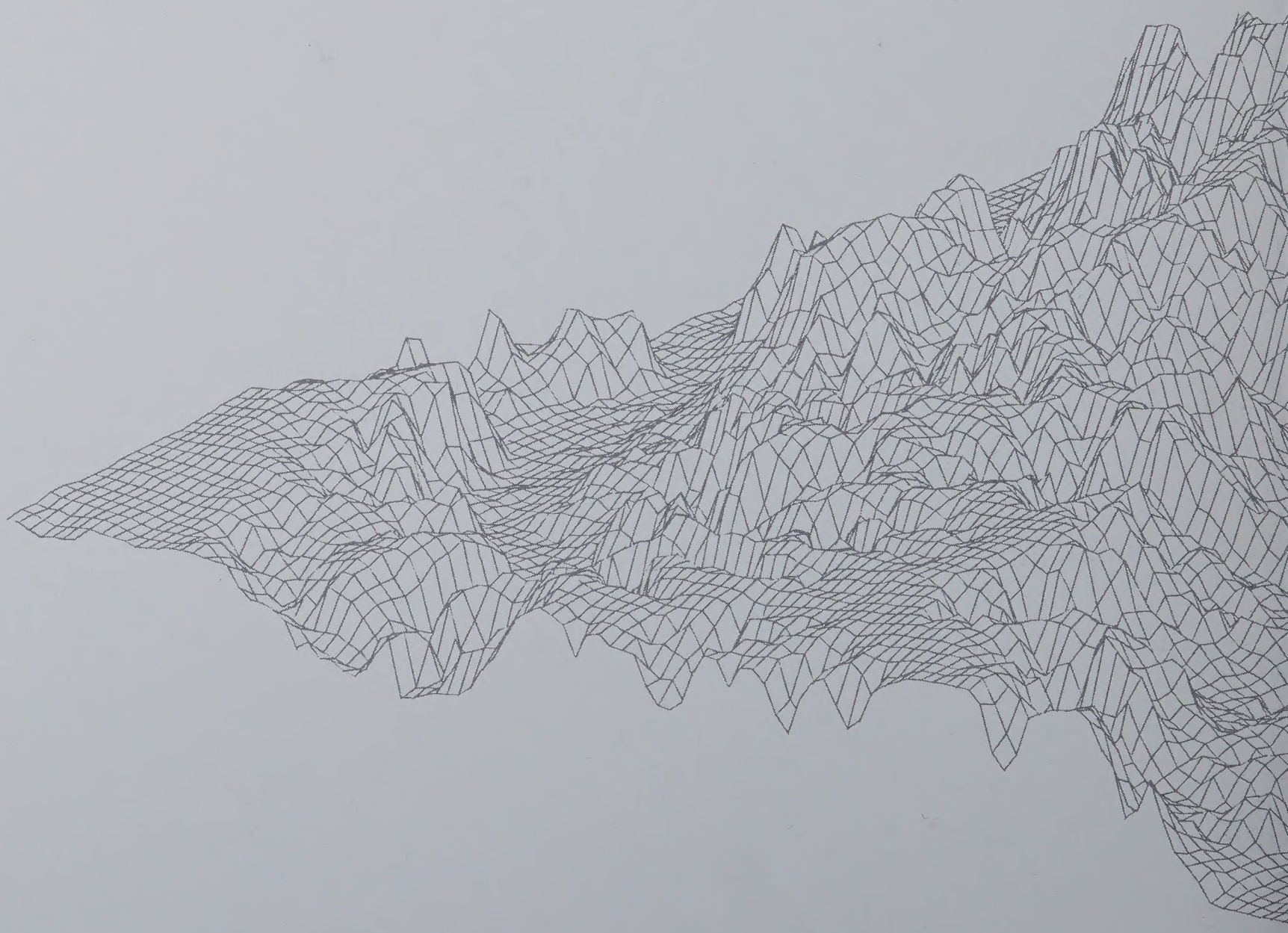

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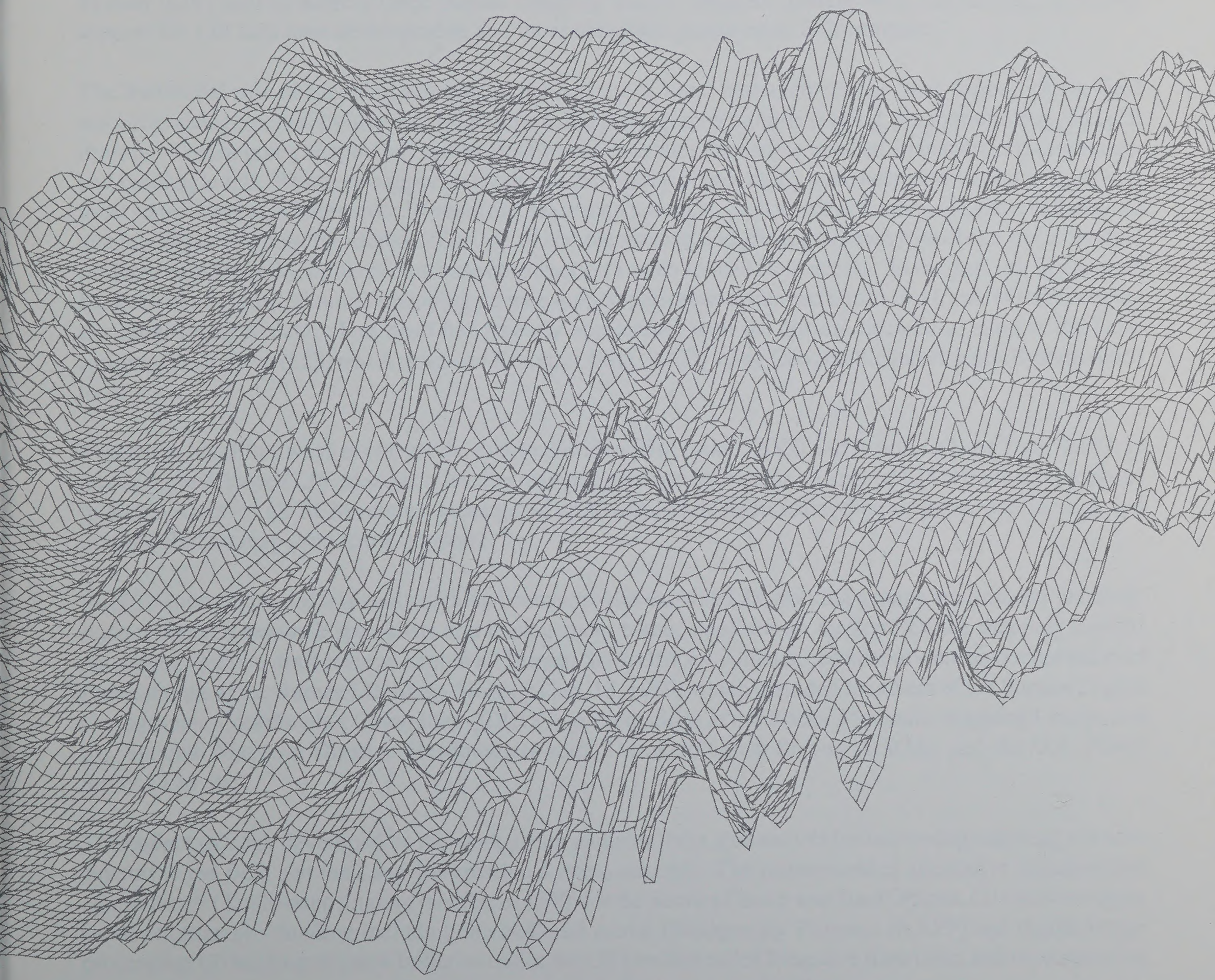
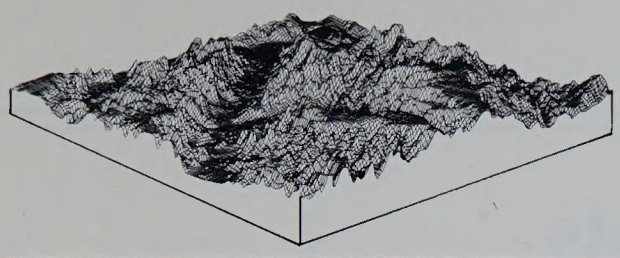




Resource Mapping Support Study for the BLM's Land Information System - Executive Summary

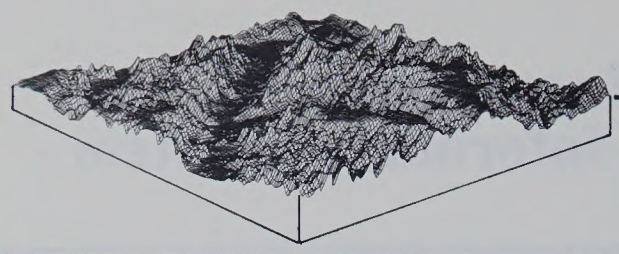
The Resource Mapping Support (RMS) Study was initiated by the Washington Office Land Information System (LIS) staff to address three Bureau mapping issues: program management and funding, increased support for LIS data base development, and more consistent bureauwide field support.

The traditional role of mapping sciences in the Bureau of Land Management has been support of the field resource management activities in cartography, aerial photography, remote sensing, photogrammetry, and plat drafting. This ongoing support has varied greatly between states depending on need, management perspective, and funding levels. Resource support activities such as aerial photography have been almost nonexistent with most states' coverage being over 10 years old. Base map products, such as orthophotoquads, have had varying availability throughout the Bureau. The use of remote sensing and photogrammetry has been for individual projects with limited long-term data base construction and continued field access. In the past few years there has been increasing pressure on mapping science support personnel to convert traditional forms of resource data to digital resource data. This need has recently accelerated with the current demand to support the Land Information System (LIS) and Automated Resource Data (ARD) using Geographic Information System (GIS) tools.

This study identifies ways to correct the previously identified lack of ARD and Resource Base Data (RBD) to have a more balanced LIS, to support Bureau resource management needs. A special LIS initiative is proposed to create RBD for all BLM interest areas using cost share/work share with other agencies, contracting, and internal Bureau map production support.

Coordination efforts for this study included contacts with existing LIS working groups, preliminary presentations to Bureau resource specialists and management teams, peer review by State Office mapping support personnel, and two draft reviews sent to all Bureau State Offices. Outside comments were also received after presentations at the Bureau LIS Mega Meeting (Jan. 13, 1989) which included members of the Interior Digital Cartographic Coordinating Committee (IDCCC), presentations at the Rocky Mountain Mapping Center, and the National Mapping Division Headquarters staff, U.S. Geological Survey (USGS), and the U.S. Forest Service LIS staff.

The budget strategy developed by the work group includes three alternatives for improving mapping sciences support to the field and the Land Information System concept. The recommended alternative includes four components: (1) allocated funding (similar to 4540) for the Service Center and State Offices, (2) cyclic resource aerial photography funding including the National Aerial Photography Program (NAPP) and digital image processing, (3) funding of a new initiative under the LIS concept called Resource Base Data, and (4) continuing activity-level special support under the historical benefiting activity funding system.



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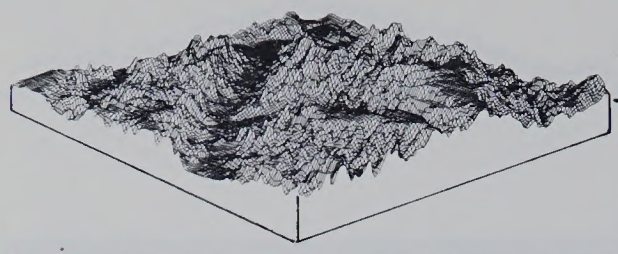


Introduction and Purpose

The Resource Mapping Support (RMS) Study was initiated by the Washington Office's Land Information System (LIS) staff to address three Bureau mapping issues: program management and funding, increased support for LIS data base development, and more consistent bureauwide field support. A core team was selected to complete an initial study in 2 months *(see Appendix 1)*. The short deadline was necessary to meet the 1991 budget planning cycle. In draft form this study was titled "Mapping Sciences Plan", but was changed to the RMS Study to better fit the Bureau's mapping activities.

The traditional role of mapping sciences in BLM has been support of the field in cartography, aerial photography, remote sensing, photogrammetry, and plat drafting. This ongoing support has varied greatly between states depending on need, management perspective, and funding levels. Resource support activities such as aerial photography have been almost nonexistent with most states' coverage being over 10 years old. Base map products, like orthophotoquads, have had varying availability with only two states having reasonable coverage. Remote sensing and photogrammetry use has been for individual projects with limited long-term data base construction and continued field access. In the past few years there has been increasing pressure on mapping science support personal to convert traditional forms of resource data to digital resource data. This demand has recently accelerated with the current demand to support the LIS and Automated Resource Data (ARD) using Geographic Information System (GIS) tools.

The Public Land Survey System/Geographic Coordinate Data Base (PLSS/GCDB) needs mapping to provide control through the use of a digitized landnet from topographic maps and photogrammetry. The ARD efforts needs mapping support to: (1) provide the digital base layer, i.e., the Resource Base Data (RBD) consisting of topography, hydrography, transportation, and other cultural infrastructure features; (2) apply geographic coordinates to all resource data; and (3) provide aerial photography/remote sensing/ photogrammetry to locate and maintain (update) digital resource data. Mapping sciences, through plat drafting/digitizing, can also provide the as built right-of-way (ROW) and easement locations to complete the digital master title plat.

What are Mapping Sciences in BLM?

Mapping sciences are the methods, techniques, and theories for collecting, processing, and displaying positional information about the earth and its administrative, cultural, and physical resources. Within the Bureau these mapping sciences tools and techniques are applied as required to support decision making in multiple use resource management and traditionally include cartography, map digitizing, photogrammetry, aerial photography, photo interpretation, and digital satellite image processing. Mapping support techniques used by the BLM provide diversified and specialized products and services in support of resource management activities.

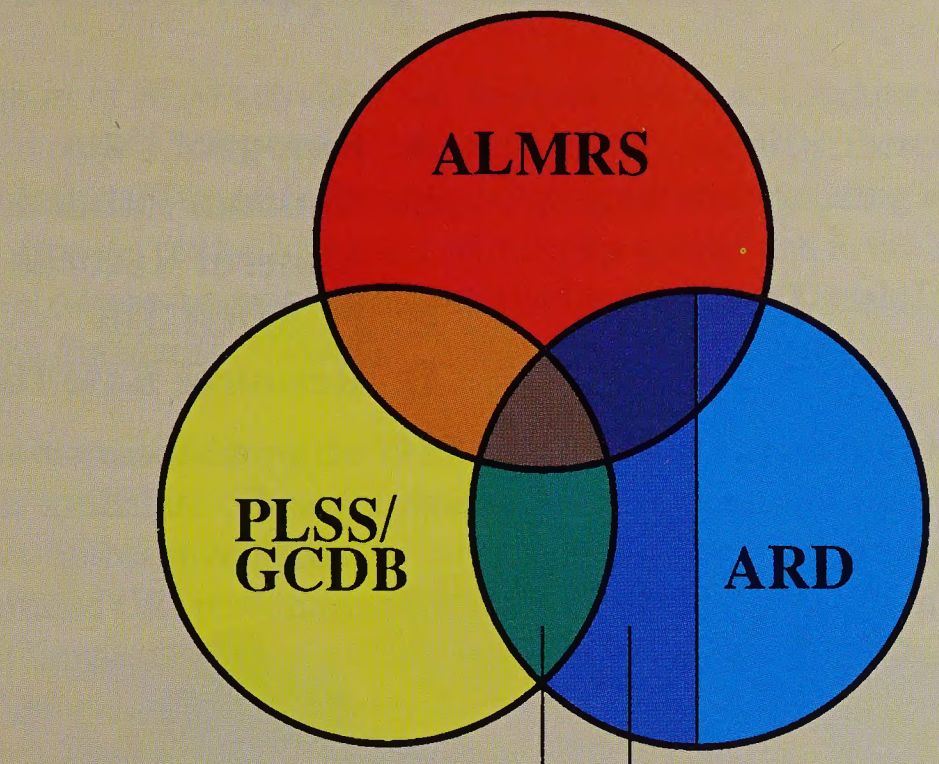


Figure 1

Mapping Sciences Tools for LIS Support

What is the Mapping Sciences Relationship to LIS?

The Land Information System in the Bureau includes automated records data (ALMRS), landnet coordinates (PLSS/GCDB), and ARD along with the automated processes such as digital graphics, GIS, and relational data base management systems (RDBMS) to provide for modernization in multiple use land resource management. The Bureau's resource mapping support programs provide the following six services for the Bureau's LIS:

1. Converts existing resource data to ARD and assists in the conversion of landnet data to PLSS/GCDB.

2. Links ARD, GCDB, and ALMRS into an LIS for resource management.

3. Applies data standards for geographic coordinate locations.

4. Defines ARD spatial location by applying geographic coordinates which is the main common denominator for Bureau resource data.

5. Establishes traditional hardcopy bases for natural resource inventories and cartographic products.

6. Assists in resource data collection and inventory through mapping, aerial photographic interpretation, and digital satellite image processing.

The roots of the Resource Mapping Support Study date back to the Bureau's Automated Resources Requirements Study (ARRS). The ARRS identified bureauwide benefits from ARD and the initial cost increases to construct resource data bases. While the ARRS estimates of data base contruction were conservative, it included costs of $5 to $6 million (1985 dollars) per year for several years for all resource data. The RMS Study proposes to separate resource data capture into two groups: (1) Resource Base Data (common to all Bureau disciplines) and (2) Automated Resource Data; and to capture the resource base data through a special funding initiative.

A. Resource Data
B. National Public Land and Mineral Records
C. PLSS/GCDB
D. Resource Base Data

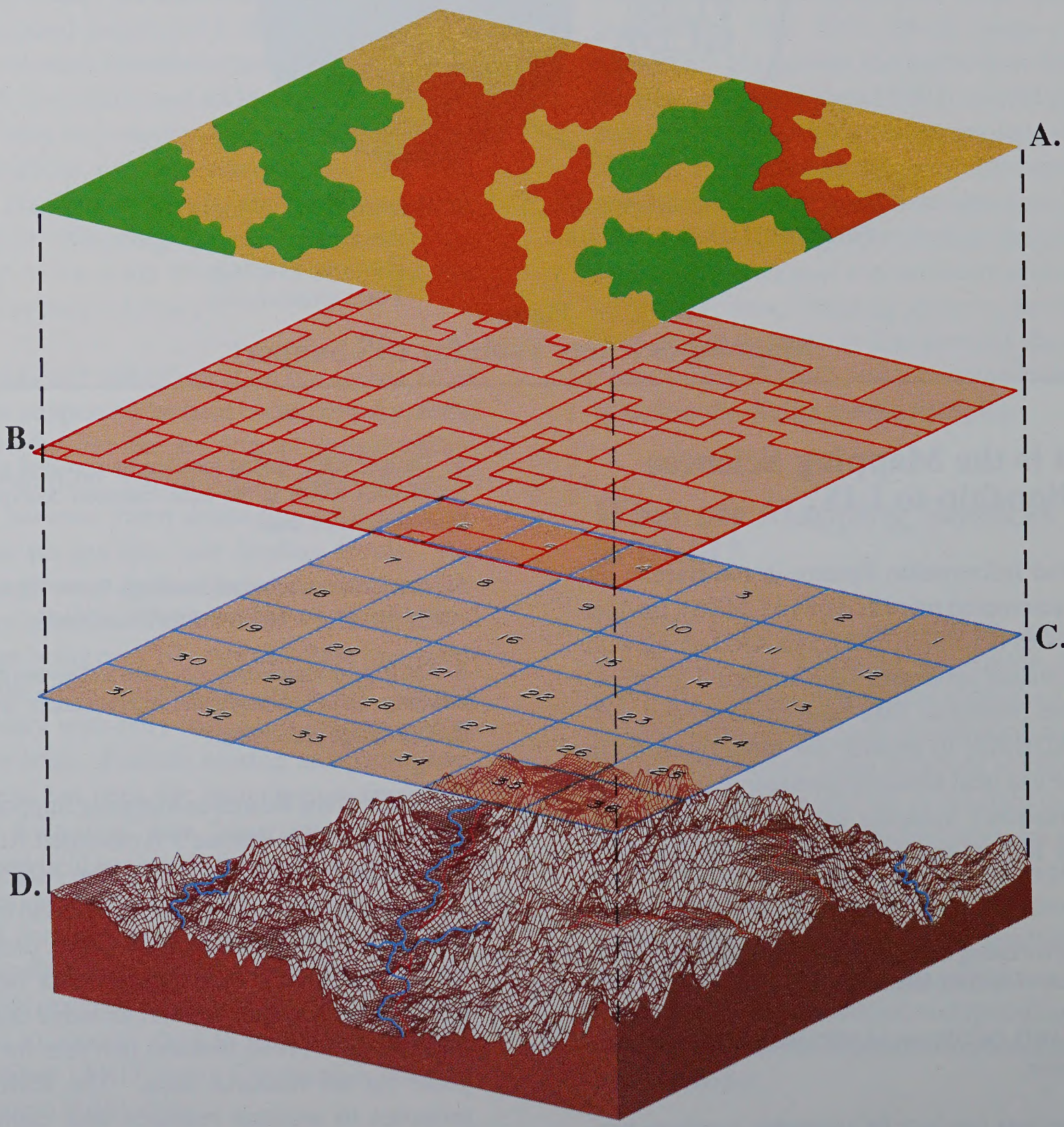


Figure 2
The Bureau's LIS Concept

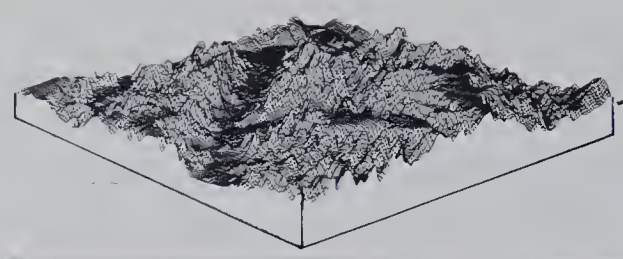
Background of BLM's Mapping Sciences Support

Mapping sciences support of BLM activities can be described as an unplanned evolution. Support activities were traditionally based on providing master title plats (MTP), use plats, thematic maps, and ownership maps to BLM resource and management staff. These activities grew into providing BLM and the public with formal cartographic products, first the old half-inch to a mile "color quads" and in the late 1970's, a professional standard surface and mineral ownership map series portrayed on a 1:100,000 scale USGS topographic map meeting National Map Accuracy Standards (NMAS).

Aerial photography use increased during the 1950's and 60's, but was mainly a hit-or-miss program using other agency photography if available. Photogrammetry was used only for road construction, recreational site development, intensive timber inventories, or other small engineering projects. In the early to mid 1970's several cyclic color infrared (IR) resource aerial photographic projects were started to support range inventories for Environmental Impact Statements (EISs) and, in the early 1980's, coal and oil shale activities in a few states. The so-called cycle turned into a one-time partial coverage of BLM high interest areas. Most of the Bureau and other agency aerial photographic coverage is now over 10 years old and does not cover the increased mineral and public use in the late 1970's and 1980's that changed the face of public lands. The National High Altitude Photography (NHAP) program covered most of BLM's land with small-scale aerial photography in the late 1970's and early 1980's. While valuable for some map updates and orthophotography, Bureau studies have shown that our field office resource staffs prefer 1:24,000 scale natural color aerial photography for resource management. In the past five years photogrammetry demand has increased ten fold. The need to make digital base and resource maps has increased greatly due to better technology which allowed the use of digital mapping products at the field level. Also, demand for analytical measurements for product verification, trespass identification and measurement, hazardous waste site reclamation, and intensive inventory site management has increased photogrammetric workloads. Only three states (Alaska, Oregon, and Wyoming) and the Service Center (SC) have photogrammetric production capabilities. Examples of this increased need are: (1) western Oregon's need to photogrammetrically produce digital base maps (Resource Base Data) for the intensive timber management Western Oregon Digital Data Base (WODDB) project, (2) Alaska's use of photogrammetry to assist in riparian surveys, (3) Wyoming's independent coal production verification photogrammetry efforts, and (4) the SC production of New Mexico's digital terrain data, oil and gas well location, and road access maps.

BLM's remote sensing digital activities started in the mid 1970's with the use of data from the initial lower resolution digital satellite, the Earth Resources Technology Satellite (ERTS). The Bureau purchased its present digital (remote sensing) image processing computer in the late 1970's to support increased demand for vegetation, land use analysis, fire fuels mapping, and digital mapping. This centralized system has been used for individual project support in a developmental and scientific research mode for the past 10 years. The recent higher resolution LANDSAT Thematic Mapper (TM) and SPOT imagery data, along with field GIS capability to use digital maps, has greatly increased demand for automated analysis and data from digital image processing.

The growing field office GIS capability to use digital map data under the Bureau's LIS concept has increased the demand for mapping sciences support services and products. Map digitizing has been increasing at all levels of the organization, starting in the mid 1980's, with the GIS ability to analyze spatial resource data for land management use. Implementing the LIS concept will put increasing pressure on the Bureau's limited mapping science capability to convert resource data to a digital base for modern land management in the 1990's and into the next century.



Functions and Products

Mapping Sciences Role as Support to Field Users

The primary role of mapping sciences in BLM is technical support to field resource staff by the production of both hardcopy cartographic products (maps and engineering drawings) and digital products for GIS analysis. The role of data capture and conversion, i.e., transforming resource data from a graphic map, aerial photography, or digital image to a digital data base is a key ingredient in the LIS concept. This new role will be carried out in four ways: (1) centralized at the State Office, (2) decentralized at District and Resource Area Offices, (3) centralized support contracting and quality control at the Service Center, and (4) Service Center special project support including scanning, photogrammetry, and digital image processing.

Basic Functions and Products

BLM has traditionally divided the mapping sciences support into the following categories:

Cartography	Photogrammetry
Drafting, general	Remote sensing
Photolithography	Aerial photography
Map digitizing	Photo interpretation
MTP drafting	Plotting

The RMS Study core team has divided these traditional categories into 16 functions *(see Appendix 2)*. The specific services and products currently produced by BLM mapping sciences professionals include:

1. Mineral and surface ownership map series: 100K, 500K, and 1,000K as a national program.

2. Natural color and color IR aerial photographic contracting, coordinating, and photo reproduction.

3. Digitizing of resource data.

4. Photogrammetric and map compilation of base map data, specific resource data, data maintenance, digital terrain data, and orthophotographs.

5. Map design, scribing, ink drafting, and layout for Bureau publications including EISs, RMPs, activity plans, and other documents and maps.

6. Photolithographic reproduction for base map duplication, aerial photography printing, color map proofs, etc.

7. Photogrammetric engineering and surveys including volumetric measurement analysis and site designing support including the production of digital elevation models and orthophotographs.

8. Photographic interpretation and training of resource staff to perform photo interpretation.

9. Digital image processing of satellite-derived data traditionally identified as remote sensing.

10. Digital image analysis and products including vegetation mapping, fire fuels mapping, resources change detection, and slope and aspect mapping.

11. Master title plats (MTPs), use plats, and special plat drafting.

12. Special base map construction, e.g., oil and gas well field maps. (These have a high potential for automation under LIS.)

13. Digital map design and output plotting on color pen, electrostatic, and laser plotters.

14. GIS application assistance and digitizing are under the mapping sciences staff in Wyoming, Idaho, New Mexico, and Colorado and partially in California, Utah, Alaska, and Oregon.

Evolving Resource Mapping Support Functions

The methods/techniques and capabilities of resource mapping support in the Bureau continue to evolve due to increased automation and demand for digital products and services. The change in support emphasis from manual to digital methods has increased responsibility for data standards and documentation. Digital base map data must have better standards and full documentation because of the potential to reuse this data for many resource needs both within and outside the Bureau.

The demands of LIS and the Bureau's modernization process require that the unplanned growth in mapping science be directed and managed to maximize its efficiencies and capabilities to build the resource data bases in the future and maximize the use of USGS National mapping products. While existing mapping sciences capabilities may meet the Bureau's immediate needs, they cannot meet modernization and data conversion demands required by LIS at the present funding levels and low program emphasis. This study is the first step in planning to meet the increasing demands for mapping support in the Bureau over the next 10 years.

BLM Role in the Mapping Community

The BLM, an agency of the U.S. Department of the Interior, manages approximately 272 million acres of public lands - about one-eighth of the land in the United States - and the mineral estate underlying another 300 million acres of lands administered by other government agencies or owned by private interests. Public land resouces managed by BLM include rangeland, timber, minerals, watershed, fish and wildlife habitat, wilderness, recreation, and archaeological and historical values.

The Bureau maintains the Public Land Survey System including most of the Federal land tenure records. This requirement, plus multiple use management, has created the need to show public lands on the national surface and mineral management maps at 1:100,000 scale. These professionally-produced color maps are the only national mapping product produced by BLM and made available for public use. All other mapping science products are produced for internal Bureau support although they can be and are used by local and state governments and other federal agencies.

Value-Added Products

The Bureau uses cartographic products from other mapping agencies such as the USGS topographic maps, orthophotoquads, and digital line graphics (DLG) and Soil Conservation Service national soils data bases. The Bureau has to transfer/ convert this data to the Bureau's computer format and data structure to use with BLM's analysis software. Then BLM adds value to the data by adding common resource management attributes *(see Figures 3 & 4)* to the attributes supplied by other agencies. These additional attribute fields make a map data base like DLG into a resource data base like the BLM Resource Base Data layer *(see Figures 4 and 5)*. These layers have to be continuously maintained/updated to be utilized in ongoing projects.

Where management needs dictate, an increased level of detail must be added to the Bureau's Resource Base Data. This intensification of both DLG and Digital Elevation Model data is necessary to more accurately depict features required for intensive land management. Examples include detailed transportation networks in an oil and gas field where standard base mapping only shows a representative pattern (generalization) and the Bureau needs detailed access information. Standard USGS DEMs do not fully meet Bureau needs in areas of intensive management. Standard DEMs produced from scanning high altitude aerial photographs at the ±7 meter accuracy do not meet the Bureau needs in areas such as potential surface mine studies in the Wyoming's Powder River Basin or preliminary timber access road design in western Oregon.

This three-step value added process (CONVERT-IMPROVE ATTRIBUTES - UPDATE) has to be performed on Resource Base Data prior to the Bureau's use in LIS at the field level.

Wellpads and Roads Compiled from Photogrammetry (SC)
Roads Collected from DLG's
Streams Collected from DLG's

New Mexico State Office - 1989

Figure 3

Resource Base Data Mapping of Transportation and Oil & Gas Well Drill Pads Showing Value Added in Roswell District

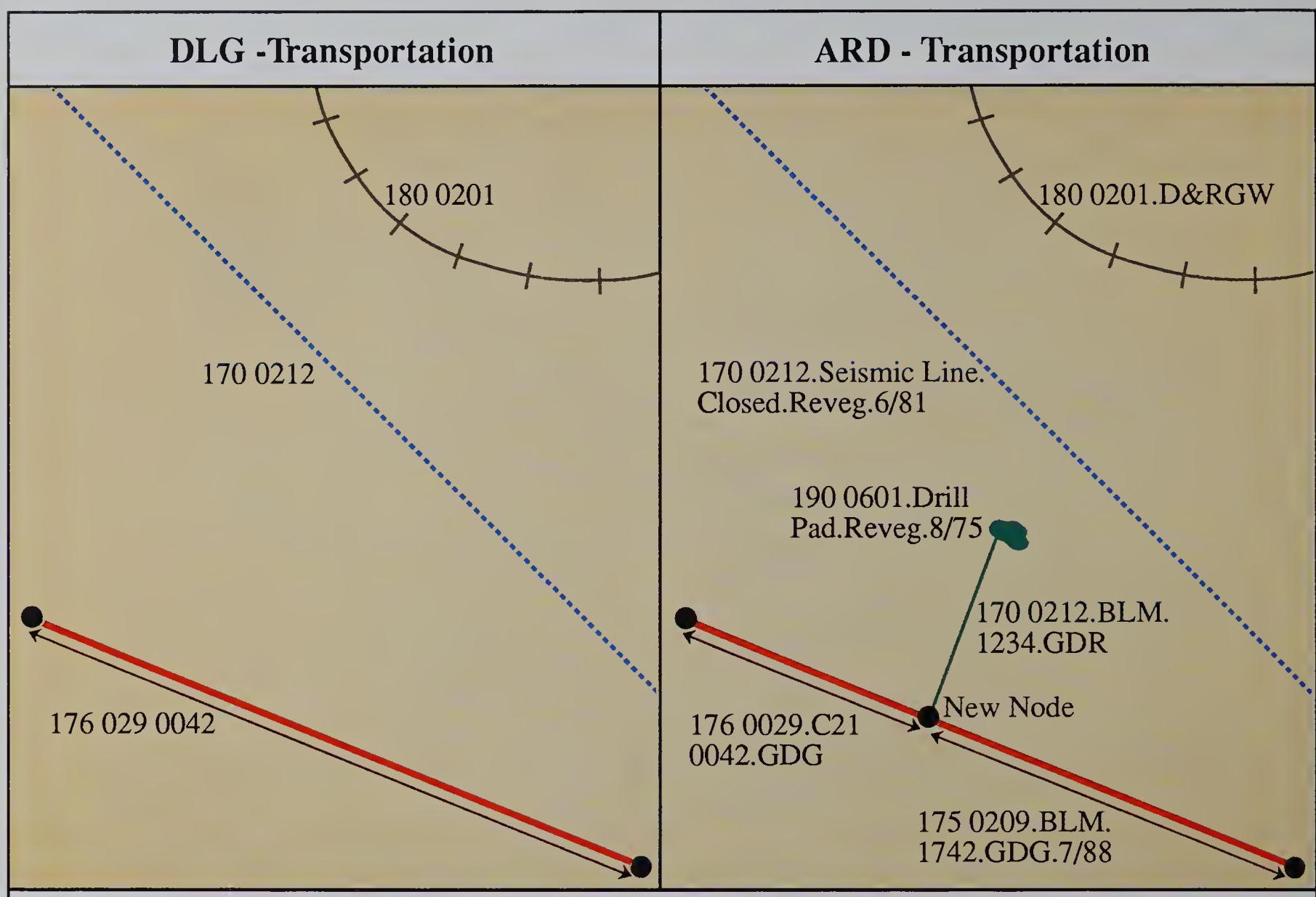


Figure 4
Value Added Example

Types of Bureau Data

The Bureau requires more specific information than depicted on the standard topographic map series. Where a USGS topographic map will show a two-track jeep trail, the BLM Resource Base Data may show a closed and revegetated seismic line *(see Figures 4 & 5)*. Resource management requires more interpretation than is first apparent in the base mapping process. In some situations the Bureau needs increased accuracy/resolution of base data. When calculating overburden on potential coal strip mines, elevation data at least twice the standard USGS DEMs accuracy and resolution is required. Seven meter or 15 meter DEM data would cause an economic mine model to have an unusually high cost versus coal production benefits.

Priority Differences

Very little base data is available in BLM high interest areas. Less than five percent of Bureau lands have transportation and hydrography DLGs at the 1:24,000 scale *(see Figure 6)*. DEMs are available on only a third of BLM managed western lands *(see Figure 7)*. The startup time to provide these products is normally too long to provide a digital product for active projects. At least two years lead time is needed by mapping agencies to produce these products at a reasonable cost.

USGS Standard Attribute Coding for Digital Line Graphs

170 0209
Road or street, class 3

This code describes a centerline digitized in a class three road or street shown by symbol 105(A). or by symbol 116.1(B). It is also used for symbol 2103.01 and 2103.02(D) when unlabeled as to administrative responsibility.

BLM Road Inventory System (ARD)

Data Entry Routine

ROAD NAME:	(NAME)				
ROAD NUMBER:	(1234)	ROAD SEGMENT:	(1.50)	ROAD SPUR:	(01)
STATE:	(WY)	CONG DIST:	(99)	COUNTY:	(125)
DISTRICT:	(33)	RES AREA:	(22)	MERIDIAN:	(66)
TOWNSHIP:	(0340N)	RANGE:	(0290E)	SECTION:	(06)
ALIQ PART:	(NESW)	BEGIN MILE:	(1.50)	END MILE:	(3.66)
LENGTH:	(2.16)	FUNCT CLASS:	(L)	JURISDICT:	(BLM)
AVE WIDTH:	(14)	SURFACE:	(N)	ES SPEED:	(10)
RESTRICT:	(14)	MAINTAINER:	(BLM)	PERMITS:	(N)
MAINT LEVEL:	(2)	EAS ACQUIRED:	(WY 12345 5 678901 22)		
EASE NEEDED:	(0)	ACCESS RIGHT:	(BP)	CI COST:	(15)
USER DEFINED:	(USER INFO)			DATE:	09/23/88

Figure 5
Comparison of DLG and ARD Attributes

A recent major Resource Management Plan (RMP) in Wyoming using seven meter USGS DEM data required an additional 18 DEMs which were not delivered within 24 months. Any large block area requires extensive lead time to meet production requirements. If BLM expects to use these base products in resource management, the areas must have prior coverage. If the Bureau plans to have this RBD on high interest areas available by the target system turn-on date, it will require at least five years lead time.

The Bureau plans to use appropriate standard products from all sources, adding value and utility as necessary to meet our resource management needs.

Agency Cooperation

The Bureau has initiated cost share and work share cooperatives with other agencies to produce standard mapping products. Existing programs include orthophotoquads, 1OOK map series, DEMs, and aerial photography using guidance from the Office of Management and Budget (OMB) Circular A-16, interagency agreements, memoranda of understanding, cooperatives, and direct purchases. See Appendix 3 for an example of a current interagency agreement. It is essential the Bureau utilize outside source capabilities, such as private contractors and other agencies, to meet this large pending workload.

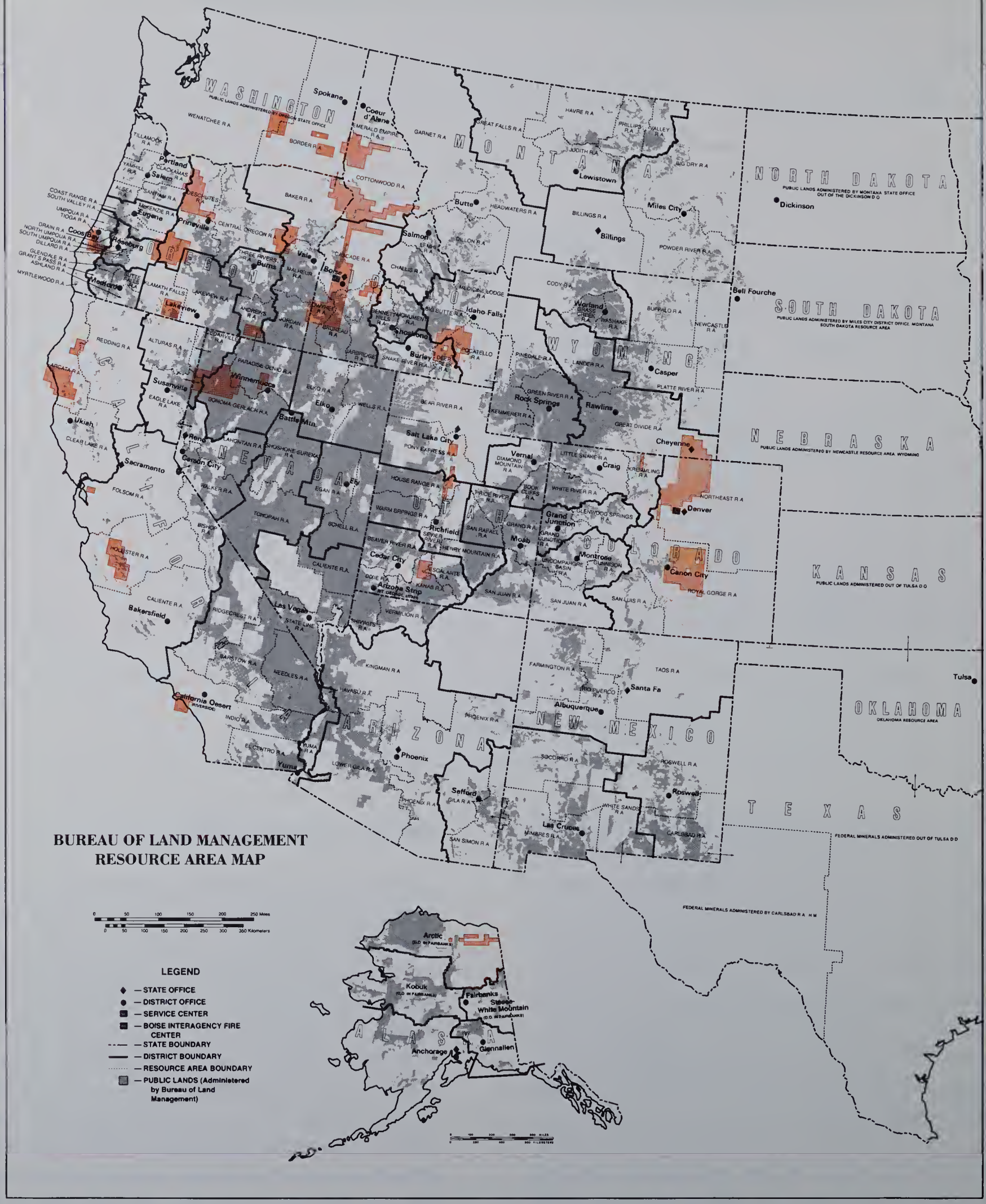


Figure 6

7.5' Digital Line Graphic Availability Map*

* Non PLSS layers

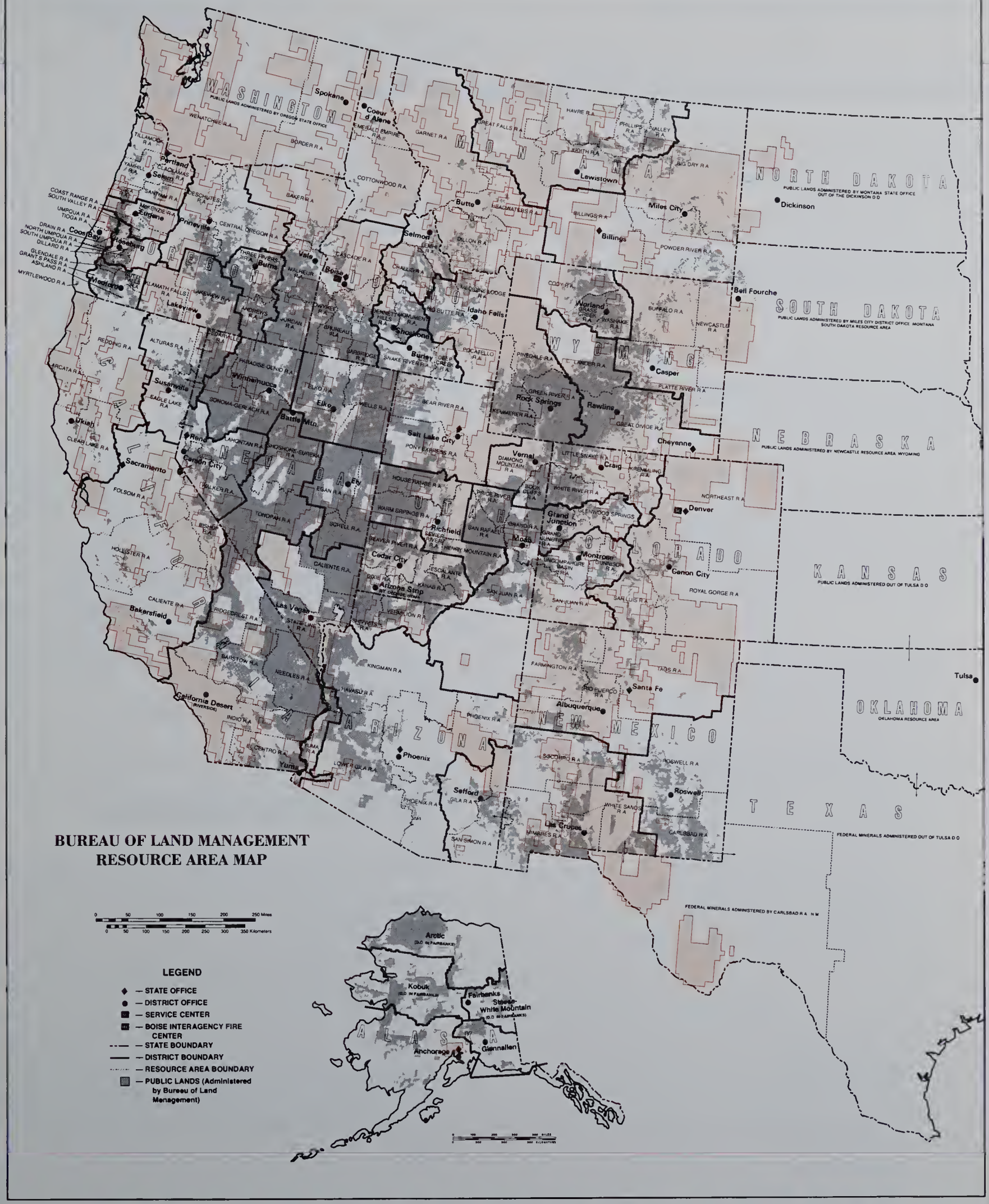


Figure 7

7.5' Digital Elevation Model Availability Map

Contributions of Mapping Sciences to LIS

Main Source for Resource Base Data

Mapping sciences tools and techniques are the primary source for Resource Base Data. This data includes data sets common to all Bureau LIS/GIS users. They include terrain, transportation, surface hydrography, and cultural infrastructure features. See Appendix 4 for the definition of Resource Base Data layers.

Mapping Sciences Ongoing Support to ARD and LIS

Specialized data capture, resource data maintenance/update, and providing base mapping media support are mapping sciences contributions. Listed below are some of the main sources and tools:

Sources

Base & resource maps
Aerial photography
Digital satellite imagery
Orthophotography
Global Positioning Systems (GPS) resource data collection
Historical documents
Survey data
Field investigation data
Digital Elevation Model (DEM)
Digital Line Graphic (DLG)
Land & Minerals Records data

Tools

Tablet digitizing
Scan digitizing
Photo interpretation
Image processing
Photogrammetry
Digital editing
Cartographic design
Specialized map output
Project design assistance
Photographic reproduction

Common Technology Sharing

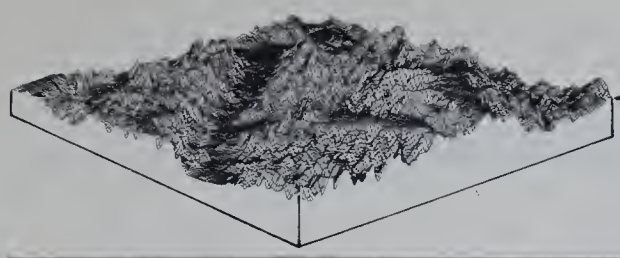
The many separate Bureau programs (subactivities) share both spatial location and mapping sciences technology. Most resource data must be compiled into a map product prior to entry into a Geographic Information System (GIS). Display of resource data also requires manual or digital base map data for reference. Most resource data collection can share aerial photography and digital imagery for both data inventory and data maintenance sources.

Location to Positional Relationships

Technologies available through LIS emphasize the increased need for resource data positional accuracy. In the past we located data by referencing a map or plat, but automation requires coordinate positions for the resource data. In a GIS the data is stored by attributes and associated coordinates. This positional coordinate (latitude/longitude) allows analysis by computer programs of resource spatial relationships.

Analysis (Cartographic Modeling)

Resource data coordinates in our data base allow special spatial processing tools such as GIS to be used in analysis. Combinations of Resource Base Data may constitute an ARD layer. DEMs and digital hydrography can be processed into a slope versus distance to water model for range suitability analysis. With the proper data and techniques available, analysis similiar to this can be accomplished by field resource specialists. Coordinates allow resource data to be compared/analyzed by GIS.



Benefits

The benefits of mapping science to LIS are:

1. Supplies ARD source products for all BLM field activities:

Resource base data
Aerial photographs
Satellite imagery
Orthophotomaps
Base maps (traditional and digital)
Digital Elevation Models (DEMs)
Digital Line Graphics (DLGs)

2. Supplies mapping sciences tools and techniques for all BLM resource activities and inventories:

Photo interpretation
Digital imagery analysis
Photogrammetry
Digitizing
Cartographic design
Map and imagery plotting

3. Links resource data with PLSS/GCDB and ALMRS.

4. Eases resource data conversion and exchange.

5. Provides common data base for all resource data.

6. Improves data consistency, currency, and positional accuracy (more defensible decisions).

7. Provides the resource manager with "what is where".

8. Provides an important source for ARD.

9. Aids in the collection of resource themes.

10. Identifies conflicts such as trespass identification and mapping, "as built" versus "as approved," data edge matching, common location, or classification differences.

11. Assists in the implementation of new LIS technologies including:

- Initiating scan digitizing of resource map overlays, well logs, records, and aerial photographs for use, edit, and storage in both digital and hard copy formats.

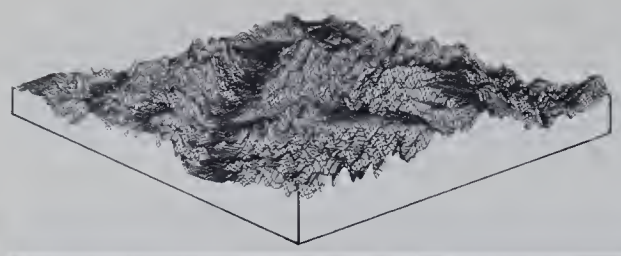
- Implementing superposition of digital satellite imagery and aerial photos onto a digital data base, i.e., being able to view the oil and gas well digital data base on a current rectified digital image. New wells and wells in trespass can be digitally added to the data base at the local field office.

- Acquiring specialized color output devices for District, State Offices and the Service Center.

- Evaluating low cost GPSs for precise resource data locations.

- Investigating analytical and digital photogrammetric equipment for State Offices and the Service Center.

- Acquiring digital 3D imaging workstations for District, State Offices and the Service Center.



Personnel, Organization and Funding History

Personnel

The Bureau has 40 cartographers (1370) and 223 cartographic technicians (1371) as of the first quarter of FY 89. An estimated 118 cartographic technicians are involved in cadastral or MTP drafting. Also, many mapping science related functions are performed by others where the workload does not warrant a full position, especially at District and Resource Area Office levels.

In the past 10 years there has been a marked increase in the number of cartographers in BLM, from 5 to 40. This change was primarily caused by increased technical requirements in the Bureau. Most of this increase has been at the State Office level. The increase should continue at a low level as the Bureau increases its data conversion efforts for Bureau "modernization."

Personnel trends show moderate changes with an increased number of cartographers. The Resource Mapping Support Study team estimates that the total number of cartographic staff will increase slightly, but a major change will occur in their functions. The funded ALMRS and PLSS/GCDB program will force changes in automated plat drafting over the next five years. The LIS, ARD, RBD and GIS advances will require more digitizing input capabilities, cartographic data management, and GIS modeling assistance. This change from manual plat drafting to cartographic digitizing will require a minimal amount of training for the cartographic technicians, but experience shows this can be done as "on-the-job training (OJT)."

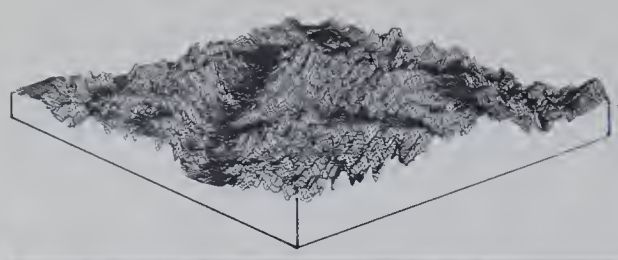
Organization

This study did not consider the organization of mapping sciences activities within BLM due to the pending bureauwide study on Information Resource Management and LIS organization *(see Appendix 7)*. Mapping sciences is a support activity found primarily in Operations or Technical Services in the WO, SC, SOs, and DOs. In the Service Center, mapping is under the Division of Technical Services, but some units like remote sensing have changed organizational locations many times over the last five years. Currently all SC resource mapping functions are in the Divison of Technical Services (SC-670). Mapping sciences at the Washington Office are currently under the Assistant Director, Support Services (WO-700).

Historical Funding

Historically funding for all mapping science activities prior to FY 89 has been the "tin cup" approach with over 30 benefiting subactivities funding states, Washington Office, and Service Center. Total Bureau funding for mapping support is estimated because no separate mechanism is available to track costs. The FY 88 estimates are $12 to $15 million for bureauwide mapping support. Funding approaches varied from taking a percentage off the top of most subactivities to allowing mapping sciences to compete at the activity level for funding. As might be expected, this caused large variations in SO mapping science support ranging from 50 WMs to over 300 WMs at some offices. Those offices with strong leadership and large single activities requiring mapping support have larger programs.

FY 89 brought significant change to mapping sciences funding. A single subactivity, 4540 (Resource Data Acquisitions and Management), was established to support the Washington Office and Service Center for mapping related activities. However, the benefiting activity approach is still used at the State and District Office levels.



Budget Strategy

The current Bureau mapping sciences operation consists of a variety of activities at the Service Center and field offices. Most field activities are centralized at the State Offices although some do occur at the District or Resource Area Office level. Service Center functions have traditionally consisted of bureauwide projects, overflow workload, or specific projects that exceed State Office technical or equipment capabilities. Mapping sciences products range from plat drafting and manual cartographic production to photogrammetric/ remote sensing data collection, digital data conversion, and technical consultation/training.

In recent years the largest impact to the mapping sciences operations has been the emergence of LIS in the Bureau. LIS has generated a greater need for mapping products, both as direct output of LIS projects and as tools for use in LIS applications.

In FY 1989 the total cost of products and services to support BLM programs and LIS was approximately $15 million. This was funded primarily from benefiting subactivities although a relatively small amount ($1 million) was dedicated funding for the Service Center photogrammetry, cartography, and photo lab operations.

The existing mapping sciences support approach and funding strategy has historically met the immediate and short-term needs of Bureau programs. However, recent trends in Bureau management objectives and the LIS concept emphasize requirements for greater long-term planning, standardization, and multiple-use data bases. The current funding strategy does not allow these needs to be met.

The proposal to meet the Bureau's changing needs, set forth in this document, consists of three components: (1) allocated funding of Service Center and State mapping operations including a cyclic resource imagery acquisition program, (2) a Resource Base Data initiative, and (3) continued special project support (benefiting activity).

Allocated Funding

The purpose of this funding proposal component is to identify the level of dedicated funding needed to support mapping sciences related activities at the Service Center and State Offices. This foundation is necessary to ensure that a consistent level of products and services are available to all users.

In the State programs, the products and services would be:

1. LIS/ARD/GCDB/ALMRS/RBD integration.
2. BLM base series support and thematic mapping production.
3. Drafting support.
4. Cartographic data base maintenance.
5. Cartographic design and special products.
6. RBD maintenance assistance.
7. RBD digitizing and specialized plat output.
8. Resource imagery applications.
9. Photo interpretation.
10. Photogrammetry/aerial photography support.
11. Mapping sciences outreach.
12. Mapping sciences training.
13. GIS/mapping sciences coordination.
14. Value adding to RBD.

Service Center products and services would include:

1. Photogrammetry.

Analytical/digital photogrammetry
DEM/orthophoto support
Resource base data precise locations
Engineering photogrammetry
Base mapping and control

2. Digital imagery/aerial photography.

Image preparation for SO systems
ARD digital image processing
Imagery acquisition and archiving
ARD photo interpretation

3. Cartography.

BLM base series finishing/printing
Central large format plotters
Map, well log, and image scanning/digitizing
Photo lab reproduction/archiving
Digitizing/data conversion

4. Professional/technical assistance.

Central expertise in map sciences
Technical interagency coordination
Systems design/application testing
Mapping sciences training
Digitizing and other contracting
Clearing house functions

Washington Office functions would include:

Program direction
Policy
Interagency coordination

Allocated funding strategy emphasizes maintenance of existing data bases and quality control. It also supports a minimal, or fluctuating, level of production, specifically, the data conversion and value-adding necessary to enhance existing data for Bureau use.

The advantage of the dedicated funding approach is the ability to plan for the long term. Consistent funding levels and personnel/skill capabilities will prevent crisis management and uncertain, or fluctuating, capacities. Long-term planning allows development and implementation of standards between states, activities, and agencies and reduces duplication of effort (as directed by OMB Circular A-16). The creation of short term or "throw-away" data bases simply to meet immediate goals is less likely. Bureau mapping sciences activities can also achieve greater flexibility to meet changing needs and better respond to multiple use management.

Cyclic Resource Imagery Acquisition

For over 40 years BLM resource managers and specialists have relied upon aerial photography to provide current, highly accurate information concerning the condition and utilization of natural resources. Aerial photography is truly a multidisciplinary tool benefiting all Bureau programs responsible for planning, inventorying, monitoring, and mapping. Most mapping products are compiled directly from aerial photography including base maps, orthophotos, digital terrain models, and thematic maps.

For photographs to be applicable to current management situations, they must be acquired often enough to portray relevant on-the ground conditions. The vast majority of BLM's existing photo data base is over 10 years old and rapidly becoming irrelevant for current resource analysis and decision making. Building and updating the Bureau's LIS data base requires access to current photography.

To partially meet this requirement, the Bureau is currently contributing $250,000 annually to the multiagency National Aerial Photography Program (NAPP). Coverage is based on 5-year cycles and the scale of coverage is 1:40,000 *(see Appendix 5)*. Alaska receives no coverage via NAPP. Although this is a useful source of information, the compromises necessitated by the multiagency nature of the program often yields photo scales and cycles not adequate for many BLM requirements.

The Service Center, Remote Sensing Section, has consolidated Bureau requirements for aerial photographs into a Bureauwide Cyclic Plan *(see Appendix 6)*. Photography coverage requirements over land in the western United States, including Alaska, are detailed. The plan consists entirely of State Office identified requirements based on localized land management activities. All States have delineated specific project areas for each year of the acquisition cycle. Although there is some variation, dominant components of the cyclic acquisition plan can be summarized as follows:

Scale = 1:24,000
Film = natural color
Cycle = 7-10 years

The entire plan will be coordinated with other agencies using 1:24,000 scale as a standard (USFS, etc.) to explore potential cooperative ventures to avoid duplication of effort and reduce cost.

To obtain the required photographic coverage, a yearly contract for $1.5 million is needed, including continued NAPP coverage and products. The cyclic photography plan is considered essential to the success of the LIS and an RBD initiative. It is expected that this program will begin to receive funding in FY 1991.

Resource Base Data Initiative

The RBD Initiative would create a comprehensive, multiple-use, spatial information data base. This data base will contain the data themes most Bureau disciplines use as a foundation for program-specific data including transportation, hydrography, culture (man-made features), and terrain *(see Appendix 4)*. These layers are common to most Bureau resource programs and are the most likely to be duplicated by independent field collection efforts inside and outside BLM. Standardized data collection/conversion efforts would eliminate that duplication and realize enormous savings.

Much of this information is currently available on printed maps. However, an extensive data conversion effort must begin to collect this data into a digital format for use in the LIS. There are apparent opportunities to acquire raw data sets from several sources including private industry contracts and work/cost share agreements with various government agencies. Once these data sets are obtained, the Bureau must "add value" to the raw data. This includes reformatting the data, adding specific attributes, and intensifying and/or updating the data.

The Resource Base Data Initiative would provide the necessary data over a 5-year period using photogrammetric, remote sensing, and digital conversion capabilities. These technologies represent varying degrees of accuracy, resolution, completeness, level of detail, and cost. The particular technical approach must be determined by program need (resource value) and data availability from other sources. For example, a high value, intense activity may require large scale, accurate mapping of the transportation network. If current, accurate data were unavailable, photogrammetric techniques and current photography would be used to collect and encode the data. If other sources could provide the required information, reformatting and encoding the information would be necessary.

Figure 9 provides a total cost estimate for this effort. The costs are based on accuracies required in relation to the resource value. The approach is similar to that used to determine GCDB priorities.

Initial Base Map (5 years @ $8.0 million/year)

Terrain
Transportation
Surface Hydrography
Cultural Infrastructure Features

Cooperatives:	● Natural Resource Agencies
	● Federal Mapping Agencies
	● State and Local Governments
Contracting:	● Private Contractors and Data Sources
BLM:	● Inhouse Digitizing/Value Added

Figure 8
Resource Base Data Types and Sources

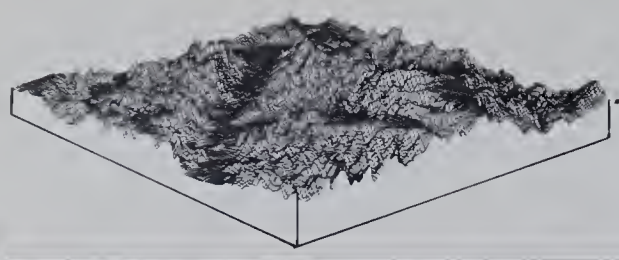
Resource Value/ Accuracy	Data Source/Method	Cost ($)	Townships	($000)
Low (75%)	Use/purchase existing data, (typical scale 1:100,000/ 1:24,000), convert data for Bureau use	500	35,500	17,750
Medium (18%)	Use/purchase existing data, (typical scale 1:24,000), convert data for Bureau use, digitize existing maps/ orthoimages, update with remote sensing and photo interpretation techniques	1,000	9,000	9,000
High (6%)	Use/purchase existing data, (typical scale 1:24,000), convert data for Bureau use, digitize current maps/ orthoimages update with photogrammetric techniques	3,000	2,750	8,250
Very High (1%)	Use/purchase existing data, (typical scale 1:12,000), convert data for Bureau use, create data with photogrammetric techniques and field surveys	10,000	500	5,000
TOTAL				**40,000**

Figure 9
Resource Base Data Workload Estimates

Benefiting Activity Funding

There are data layers and special data requirements that are unique to specific programs. Mapping sciences techniques have historically provided the products and processes necessary to meet these requirements. These activities are not only expected to continue but increase significantly, particularly in the area of data conversion. Funding for creating and maintaining this data will continue to be from the benefiting activity. This cost is estimated at $10.5 million per year. These types of products/services would include:

ARD Resource Specific Digitizing
ARD Maintenance Assistance
Special Project Direct Support
Specialized Output Products
Digital and Photo Interpretation Projects
Large Scale Project Aerial Photos
Engineering Photogrammetry
Special Base and Thematic Mapping
Non-Resource Base Data Attributing



Summary

The Bureau is faced with the task of converting its resource data sets for LIS use. Technological advancements have evolved to the point that delaying the structured start of this conversion effort will only increase the amount of backlog and cost of acquiring the data. There is also a significant intangible cost associated with not being able to use new LIS and Target System technology until the proper data bases are available.

The matrix on the following page summarizes three avenues the Bureau can take:

A. Alternative I (Preferred): Assumes a funding approach emphasizing Bureauwide standardized resource base data and consistent skill level and capacity at field offices.

B. Alternative II: Assumes a funding approach based on the Resource Base Data effort as a direct requirement of benefiting activities although consistent field office staffing levels will increase standardization capability within States. This alternative will eventually achieve the completion of the Resource Base Data initiative, but will require a three to four time increase in both completion time and costs. Because of no direct funding, RBD work would be included in on-going operational support priorities with funding competition within the traditional benefiting activity needs.

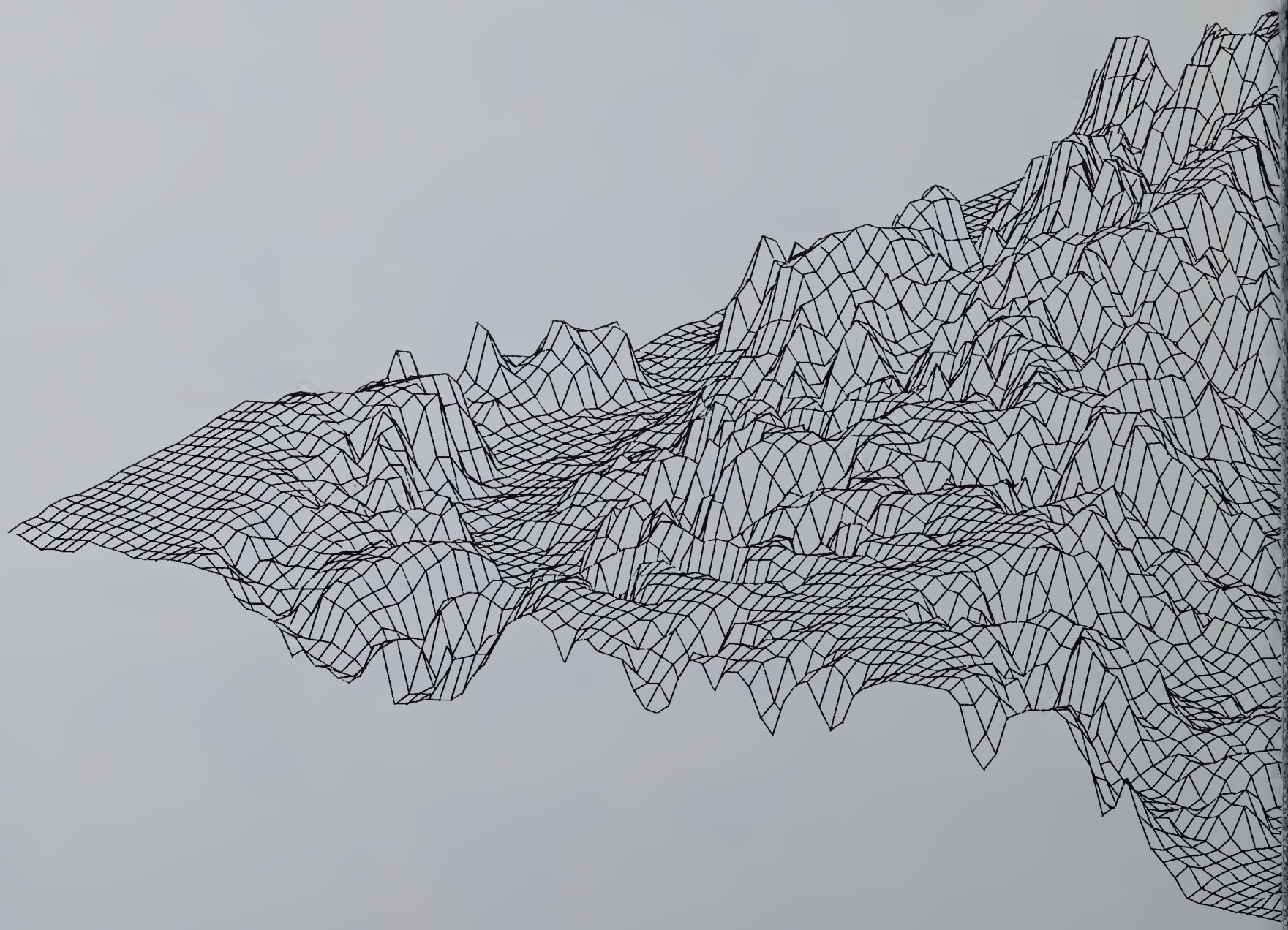
C. Alternative III: Assumes historic funding philosophy and uses FY 89 budget estimates.

Component	Yearly Cost*	Funding Source	Description*	Benefits	Concerns
ALTERNATIVE I (Preferred)					
A. Funding for WO, SC and SO	4.5	Allocated	$3.0 SC/WO personnel and services $1.5 SO personnel	1. Provides consistent field office capability 2. Allows long-term planning 3. Provides comprehensive standardized Resource Base Data 4. Increases data exchange capabilities 5. Provides current photography to meet specific field office needs 6. Allows oversight by WO to ensure field office compliance with standards	1. Requires additional funding 2. More control to WO over SO programs
B. Resource Base Data	8.0	Allocated	In house, coop, work share agreements		
Cyclic Photography		Allocated	NAPP and field office specified		
C. Special Project Support	± 10.5	Benefiting Activity	In house, coop, work share agreements		
ALTERNATIVE II					
A. Funding for WO, SC and SO	4.5	Allocated	$3.0 SC/WO personnel and services $1.5 SO personnel	1. Provides consistent field office personnel capability 2. Provides current photography to meet field office requirements 3. Only specific activities required to meet immediate needs are funded	1. Field office capacity/ fluctuating 2. Limited capability for Bureauwide standards 3. Limited long-term planning capability
B. Cyclic Photography	1.0	Allocated	Field office specified program only		
C. Special Projects	13.5	Benefiting Activity	Special Projects and Resource Base Data funded as direct-need of benefiting activities		
ALTERNATIVE III					
A. Funding for WO, and SC	1.3	Allocated	SC/WO only, personnel and services	1. Only specific activities required to meet immediate needs are funded	1. Field office skill and capacity uncertain/ fluctuating 2. Diminishes capability for standardization 3. NAPP meets only minimal field office photography requirements 4. Short term planning only
B. Special Project Support	± 15.0	Benefiting Activity	Special Projects and Resource Base Data funded as direct need of benefiting activities		
C. Cyclic	0.25	Allocated	NAPP only		

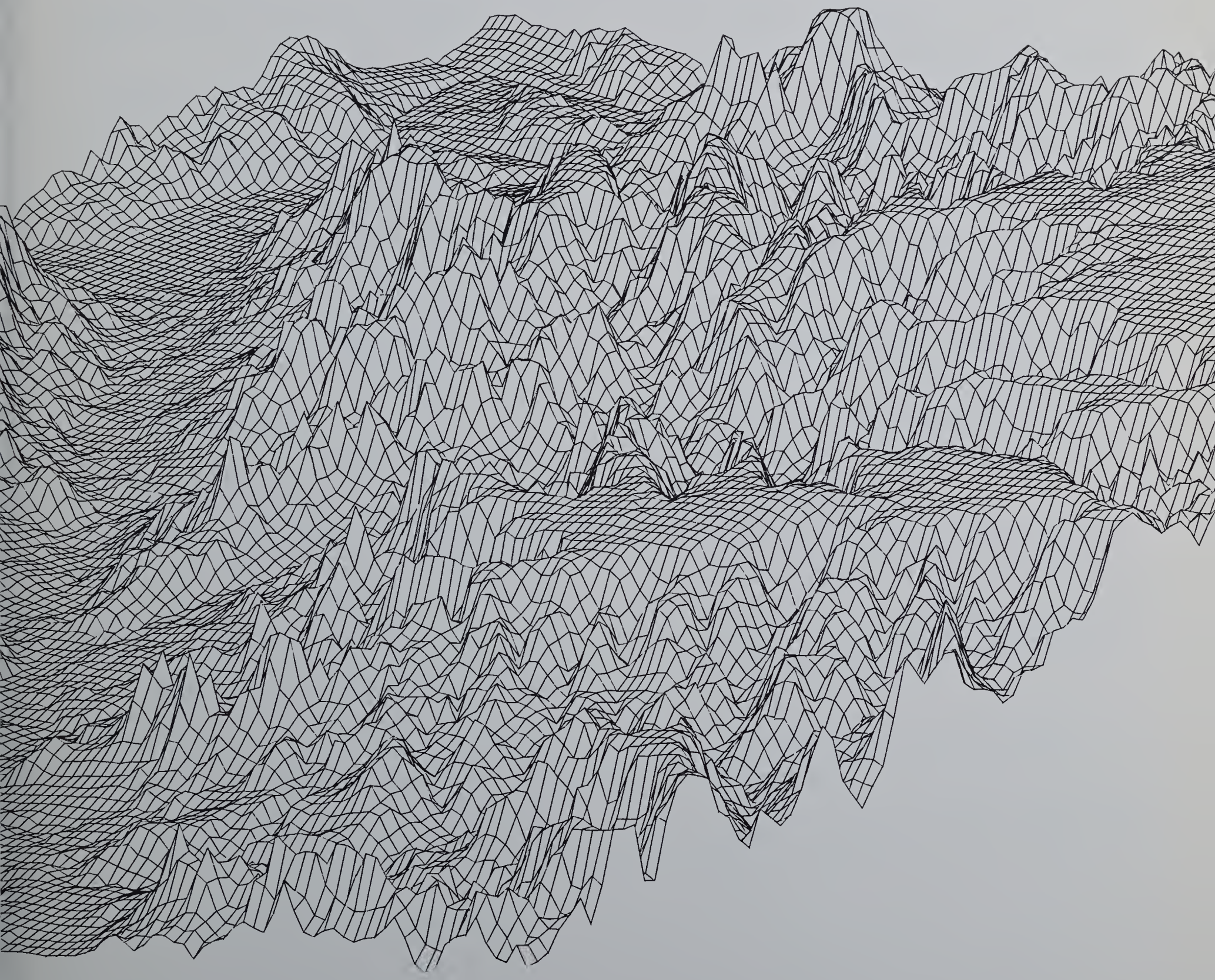
* Million $

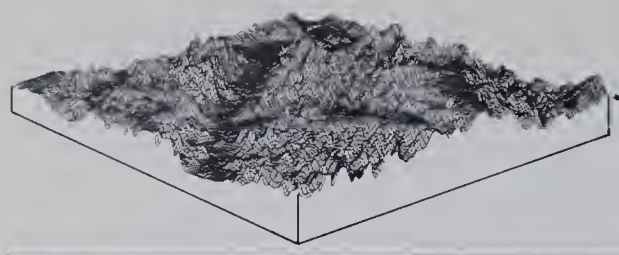
Figure 10

Alternative Funding for Resource Mapping Support



Appendix





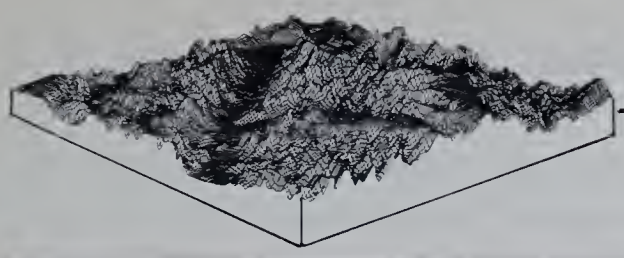
Appendix 1

Resource Mapping Support (RMS) Study Team Participants

Bruce Keating*	WY 941 (Chair)
Gus Panos*	AK 920
Steve Gregonis	CO 941
Candace Bogart*	NM 942
Tom Abbot	NV (Carson City DO)
Ted Albert*	OR 942
Bob Ader	SC-344
Chuck Tulloss	SC-670
Fred Batson*	SC-671
Marilyn Myers-Chapman*	SC-326
Mike Hutt*	SC-671
John Abrams	SC-678
Dave Meier*	WO 704

In addition, draft copies of study materials were sent to all field Mapping Science Coordinators for review and comment.

***Core team members**



Appendix 2

Resource Mapping Support Study Mapping Functions

Introduction

The purpose of this section is to identify those functions traditionally associated with mapping sciences. These functions are commonly identified as part of the map-making process, whether in the manual or automated environment. Cartographers, cartographic technicians, photogrammetrists, and/or remote sensing specialists have historically performed these functions although that fact is independent of the definition of what is, or is not, a mapping science function.

1. Map Compilation

The process of gathering spatially related data to a common base. The base may range from a network of control data to previously mapped information. The methods for map compilation may include digital imagery analysis, analog and analytical photogrammetric techniques to gather physical features from aerial photography or satellite imagery; and the more straightforward techniques of direct image transfer from one source to another. Inherent in this process are several other processes such as map registration, scale adjustments, generalization, projection transformations, and developing supplemental control networks.

A. Map Registration

The process of defining common geographic coordinates and datums for spatial data from various sources so that correct relative locations and coordinates can be interpolated for all data compiled.

B. Scale Adjustments

The process of reducing or enlarging source materials for the purpose of collecting data at the most appropriate scale for intended use. Cartographic convention dictates the use of larger scale sources for compilation integrity, therefore, the process usually involves reducing source materials.

C. Generalization

Because the compilation process often involves collecting data from larger scale source materials, it is necessary to eliminate enough detail to make display at smaller scales meaningful without compromising information accuracy and completness.

D. Supplemental Control Network Development

The process of developing additional control data from existing data to increase the compilation and registration accuracy.

2. Map Design

The process of developing the most effective display of spatial data as a function of use, audience, and data content. An appropriate design depends on graphic constraints such as color, layout, symbolism, and reproduction method and requires an understanding of visual perception, reproduction methods, graphic techniques, and audience culture.

3. Map Drafting

The process of executing the design criteria to best display the mapped data. Methods used to execute the design range from ink drafting of various point, line, and area symbols for monochrome display to creation of negatives for high quality reproduction in monochrome or full color through manual or automated means.

4. Imagery Interpretation

The process of collecting and analyzing remotely sensed data for the purpose of locating, interpreting, and categorizing physical features. Common examples of applications include definition of land use, vegetation, and geology classes. The methods used include visual interpretation and computerized analysis.

5. Spatial Data Base Development

The process of converting spatial data to digits with all necessary characteristics encoded to ensure complete and accurate utility for spatial transformations (projections, datum changes, and scales), analysis, and display.

6. Cartographic Modeling

Spatial data is often collected by combining other related data items. This "derived" data can often be determined by analyzing the spatial characteristics of one or more themes (e.g., height and distance to determine slope, rainfall, soil type, slope, aspect, etc.) to determine potential vegetation classes). Much of the analysis and consolidation can now be done faster and more accurately with the use of computerized models. Cartographic modeling uses GIS as its main tool.

7. Cartographic Reproduction

The map utility depends on the selection of the appropriate method for reproduction. Map design, drafting, and reproduction are interrelated processes which require a knowledge of graphic techniques for proper execution. These three graphic processes form a unique body of knowledge specific to map production.

8. Source Data Library Management

Historically maps and source materials have formed a valuable cache of information. Storing, cataloging, and preserving this data is an essential function for maintaining maps and source documents as references as well as tracking the history of any mapped feature. Traditionally the maintenance of this information took the form of a map library but as more and more maps are being converted to digital files, this is becoming known as data base management.

9. Cartographic Data Entry/Output, Data Base System Design

As more and more maps are being converted to digital files, the science of cartography is required to devote more attention to identification of essential criteria for development of systems which can maintain all the characteristics of mapped data. These characteristics must be maintained to ensure data integrity and accuracy as well as flexibility to serve as many uses as possible. Concepts such as projection, scale, generalization, and design are critical concerns for all phases of a spatial information system.

10. Source Material Evaluation

One of the critical requirements for data collection and/or compilation is choosing the most appropriate source for a given application. Quality assessments must be made based on content, scale, resolution, projection, distortion, age, capture method, and media in terms of the intended use.

11. Technology Evaluation

As in any science the tools, procedures, and methods used to accomplish a task must be evaluated to ensure accuracy, completeness, and efficiency. As more computerized technology becomes available to accomplish mapping tasks, the software and hardware of these systems must also be evaluated for adherence to cartographic standards.

12. Operational Development

One of the major steps in creating more efficiencies and better products in the mapping sciences realm is the ability to adapt new technologies to specific mapping tasks. This is sometimes simply adopting a system for an application for which the system was not intended, but most often involves identifying, specifying, and developing certain software enhancements to broaden the scope of a system capability.

13. Standardization

The development and implementation of standards necessary to maintain the integrity of products created by the mapping science community is the backbone of any discipline. The need for standards extends to all aspects of the process including procedures, methods, display criteria, and data bases, all of which may be in the manual or automated mode.

14. Interagency Coordination

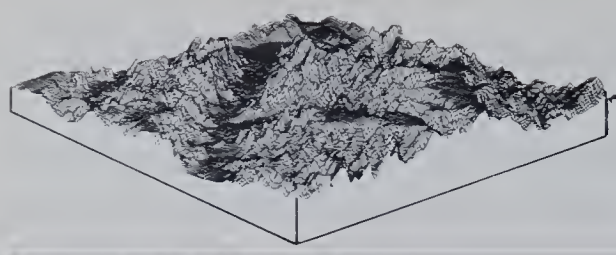
From the system perspective, many agencies have requirements which make data and technology sharing attractive. Maintaining contacts with counterparts in other agencies will facilitate data and technology exchange. This coordination is also critical for the definition of mapping standards.

15. Consultation

Many mapping science projects require consultation to help the user define and perform aspects of the project such as pre-plans, quality control specifications, contract specifications, cost estimates, time estimates, location of source materials, and desired/possible products.

16. Training and Information Transfer

Training and information transfer is necessary to maintain quality performance, ensure the use and success of new technology, and exchange ideas on procedures, products, and the user perspective.



Appendix 3

Interagency Agreement
between
U.S. Department of Interior (USDI)
Geological Survey
U.S. Department of Interior
Bureau of Land Management
and
U.S. Department of Agriculture (USDA)
Forest Service

A. Authority

This Interagency Agreement is made and entered into by and between the USDI Geological Survey, hereafter referred to as the GS, the USDI Bureau of Land Management, hereafter referred to as BLM, and the USDA Forest Service, hereafter referred to as the FS, under the provisions of 31 USC 1535, the Economy Act of 1932, as amended.

B. Objective

The objective of this Agreement is to initiate cooperative activities to eliminate duplication of effort and assure consistency of digital data. Under this Agreement, the relationships and linkages between major systems being developed by each organization in support of their own missions will be identified and an appropriate interagency coordination mechanism for addressing technical and programmatic issues related to the systems' design and implementation will be established. In addition, this Agreement will address coordination of certain specific digital data collection activities for base category, Public Land Survey System (PLSS), and other thematic or resource data which potentially may be shared between agencies.

C. Background

The Geological Survey, the Forest Service, and the Bureau of Land Management all have major programs which deal with the production, management, and dissemination of digital data: GS (Mark II), FS (Geographic Information System), BLM (ALMRS, PLSS/GCDB, LIS).

The Geological Survey's Mark II program is a development/production plan to address long term requirements and to continue development of the GS's digital cartography system through the year 2000. Mark II deals with the technical and programmatic issues of transforming an ongoing production system from a traditional graphic operation to a predominantly digital operation. The National Digital Cartographic Data Base (NDCDB) will be the central data source for the Survey's future mapping activities, including data revision and generation of both graphic and digital map

products such as 1:24,000-scale digital line graphs (DLG) and digital elevation models (DEM), 1:100,000-scale DLGs and DEMs, and 1:2,000,000 scale DLGs. For the near term, the NDCDB will continue to be primarily a cartographic data base; that is, the spatial data are in general obtained by digitizing the center or center line of symbols from the GS quadrangle maps. Later, digital revision of data in the NDCDB will be accomplished by using maps, imagery, and other source materials in an interactive mode.

The Forest Service will implement a Service-wide geographic information system (GIS) by 1991. The primary objective of the system is to implement easy to use Service-wide technology which will facilitate the access, use, and sharing of management information about resources to help the Forest Service achieve its mission. The following principles provide a focus and some guidelines for accomplishing this objective by implementing individual components and action items:

1. The nationa1 GIS technology and information structure must support the management information needed by the Agency to accomplish its mission, including addressing issues and making decisions on all lands within the National Forest System, as well as facilitating activities within Research, and State and Private Forestry.

2. GIS data must be organized and described to facilitate understanding and sharing of management information both horizontally and vertically within the organization, and between other land management agencies and organizations where possible.

3. Forest Service managers must be able to easily access the GIS technology and the information it supports via a "non-technical user-friendly" human interface.

4. GIS technology must take full advantage of the existing Forest Service computer processing and communications network.

5. GIS technology must be flexible enough to expand and incorporate new related technologies as they become available.

The Bureau of Land Management's Land Information System (LIS) is the linkage of the National Lands Records (ALMRS), the BLM resources information data base (ARD) and the National Public Land Survey System's Geographic Coordinate Data Base (PLSS/GCDB) to achieve BLM's muitiple use land and resource management mission. The LIS concept is a part of BLM's total modernization strategy which establishes the framework for the overal automation design and configuration management for the 1990's. The GCDB is derived from the PLSS and represents the foundation of the LIS and provides for the registration of records and resources information to the legal land parcel. Initial data collection will be driven by ALMRS requirements to replace the existing Master Title Plats, use plats, and other graphic outputs as well as accommodate user needs for accurate coordinate information. The PLSS/GCDB coordinates will be collected by various methods, including digitizing and computing from survey data using PLSS Coordinate Computational Software.

D. Management

A Spatial Data Management Committee (SDMC) will be established, composed of two members from each agency, and will be responsible for the overall management of this Agreement. The SDMC will:

1. Review past efforts of the GS/FS cooperative activity initiated in April, 1988 to determine if any BLM-specific concerns have been addressed, how they were resolved, and what is the impact on BLM if any.

2. Establish task work groups to address and resolve specific issues which may arise in the areas of systems development; PLSS/GCDB; and the production, exchange, and distribution of digital data.

3. Review and approve work group charters, FY work plans, and reports; and resolve issues when necessary.

E. Work Groups

Initially, three work groups wil be established:

Data Base Development/Data Distribution Work Group

The Data Base Development/Data Distribution Work Group will report to the SDMC and will provide a mechanism for issue identification and coordination related to (1) the production and exchange of digital cartographic data, (2) the development of digital data bases, and (3) the public distribution of digital data. Issues which cannot be resolved by the work group will be elevated to the SDMC. Work Group membership shall be limited to no more than five representatives from each of the three agencies; however, individual representation may change as issues change.

PLSS/GCDB Work Group

The PLSS/GCDB Work Group will report to the SDMC and will be responsible for PLSS digital data issue identification and coordination. Issues which cannot be resolved by the work group will be elevated to the SDMC. Work Group membership shall be limited to no more than four representatives from each of the three agencies; however, individual representation may change as issues change.

Systems Work Group

The Systems Work Group will be responsible for identifying the linkages and relationships between USGS's Mark II system, BLM's ALMRS, GCDB, and LIS, and the FS's Geographic Information System and for identifying the appropriate levels of coordination to insure compatibility and avoid duplication. Issues which cannot be resolved by the work group will be elevated to the SDMC. Work Group membership shall be limited to no more than four representatives from each of the three agencies: however, individual representation may change as issues change.

F. Procedures

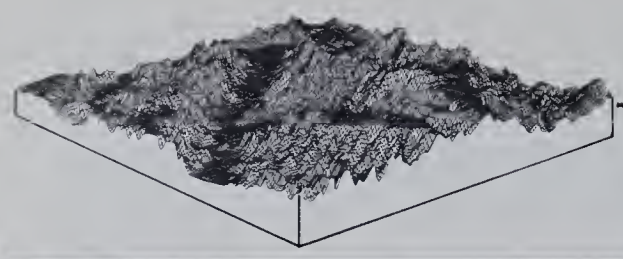
The Management Committee and Work Groups will meet as necessary to carry out the activities of the MOU. Specific tasks, agency roles, timetables, and funding responsibilities will be identified in Work Group charters and Fiscal Year work plans. Specific obligational agreements will be documented supplemental to this Agreement.

G. General Provisions

This Memorandum of Understanding is effective on the date of the last signature. This Agreement (including any future funding provisions) may be modified at any time upon joint approval, or may be terminated by any of the three agencies upon 90 day notice, or at any time by mutual consent.

IN WITNESS WHEREOF, the parties hereto have executed this agreement.

11/8/88	*/s/ Dallas L. Peck*
Date	Dallas L. Peck, Director Geological Survey, USDI
11/7/88	*/s/ Robert F. Burford*
Date	Robert F. Burford, Director Bureau of Land Management, USDI
11/4/88	*/s/ Jeff M. Sirmon*
Date	F. Dale Robertson, Chief Forest Service, USDA



Appendix 4

Resource Base Data (RBD) Definitions

Automation of Resource Base Data Themes:

Digital data used to produce cartographic products such as base maps and provide the analytic base maps for Automated Resource Data (ARD), Geographic Information Systems (GIS), and the Bureau's Land Information System (LIS). The Resource Base Data (RBD) is used by all BLM activities as base data themes.

Terrain RBD:

Describes the topographic relief of an area. Terrain data is collected as digital coordinates representing the earth surface and topography with elevation, latitude, and longitude. Interpolation of these three dimensional coordinates allows both horizontal and vertical landscape representation. These coordinates are stored in a Digital Elevation Model (DEM) or Digital Terrain Model files. The Bureau's value added would be increased coverage, resolution, and accuracy where necessary.

Applications:

- Fire behavior modeling
- RMP/EIS/EA analysis
- Timber management
- Habitat mapping
- Visibility modeling
- Physical access
- APD analysis
- Rectification of images
- Orthophoto drive tapes
- Volumes (for coal volume)
- Perspective views
- Contour mapping
- Slope and aspect mapping
- Landform classification
- Soil erosion analysis
- Watershed analysis

Transportation RBD:

The Bureau Transportation RBD effort will contain both physical and legal access information on all Bureau interest areas. This theme contains data about roads and trails, railroads, pipelines, transmission lines, etc. Attribute codes give more specific information about the feature such as whether the road is abandoned or under construction and the road number. Also, this RBD includes administratively closed areas, closed roads and trails. Value added data will include ownership, route identification and name, access and other detailed classifications.

Applications:

- Transportation network inventories
- Road classification (paved surfaces, all weather, gravel, unimproved dirt)
- Mileage calculations
- Right-of-way analysis
- Aircraft landing locations
- Access for industrial development
- Public access to BLM lands
- Firefighting logistics maps
- Field access maps
- Oil and gas well field maps
- Monitoring impacts
- Emergency service access
- Recreation (hunting, fishing, and hiking) access

Surface Hydrography RBD:

Resource base data theme consisting of all flowing surface water, standing water, and wetlands. It includes rivers, lakes, shorelines, and other hydrographic features. These files are stored in digital files called Digital Line Graphs (DLGs). Attribute codes are assigned in a DLG to identify features such as shorelines, bays, alkali flats, reservoirs, marsh, wetlands, bogs, tailings ponds, upper origin of streams, and ditches and canals. Value added would be the classification, access points, special management designations (Wild and Scenic Rivers), etc.

Applications:

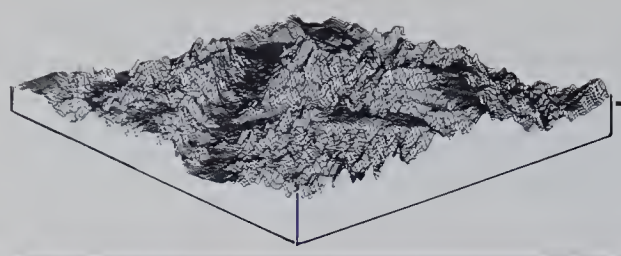
- Stream changes
- Distance to water
- Riparian zone monitoring
- Riparian cadastral boundaries
- Wild and Scenic River studies
- Drainage basin definition
- Erosion control and potential
- Fisheries habitat base
- Water rights studies
- Water availability for range, wildlife, industry development, and firefighting

Cultural Infrastructure Features RBD:

Theme containing the integrated pattern of human made features, excluding transportation. Examples of cultural features for the base data are: stuctures, well pads, gravel pits, mined areas, and fences. Also included are outlines of urban areas collected from aerial photography, orthophotos, or satellite imagery. A major category is political boundaries, including: allotment, special management, resource area and district, state ,and county boundaries. Geographic names or place locations are also included in this theme. Value added will include rangeland improvements, recreation sites, administrative sites, etc.

Applications:

- Range improvements
- Wilderness study areas
- Potential transportation corridor sites
- Time and distance analysis (distance from populated areas)
- Trespass monitoring
- Predictive modeling
- Recreation management
- Fire logistical support and limitations
- Field orientation and navigation



Appendix 5

The National Aerial Photography Program (NAPP)

Beginning in 1980 and continuing through 1986, the federal government conducted the National High Altitude Aerial Photography (NHAP) program designed to provide uniform coverage of the conterminous 48 States over a five year cycle. In the NHAP program, both black and white and color infrared aerial photographs were obtained from an altitude of 40,000 feet above mean terrain on 9-inch film. The color infrared photos, at a scale of 1:58,000 and the black and white at 1:80,000 were centered over USGS 7.5 minute quadrangles. In the six years of the NHAP program nearly all of the United States (excluding Alaska and Hawaii) were covered.

In 1986, following completion of the NHAP cycle, Federal and State agencies revised their requirements for photo coverage. The new program was entitled the National Aerial Photography Program (NAPP). The new program provided 1:40,000 color infrared coverage centered on quarters of 7.5 minute quadrangles. The second cycle of NAPP proposes to use 1:40,000 scale panchromatic coverage to support hardcopy orthophotographs and digital orthophotographs. NAPP plans call for complete coverage of the conterminous 48 states over the next five years subject to availability of adequate funds. Funds from both federal and state governments are requested and priorities are set based on requirements identified by contributors (priorities are weighted based on contributions).

Since BLM has had no agencywide acquisition program, we have been a participant in both NHAP and NAPP. The accompanying map illustrates some of the problems being encountered obtaining required coverage. Portions of several western states scheduled for coverage during 1988 and 1989 (Idaho, Nevada, Utah, Arizona) were dropped from the schedule due to insufficient funds. NAPP will not consider photography on these excluded areas until the first five-year cycle is complete. While this policy is understandable, it makes it nearly impossible to rely on NAPP coverage for BLM activities. In addition, the 1:40,000 scale is considered by the state offices to be too small for most BLM land management purposes.

NAPP will provide a good base coverage over the country. It will provide coverage in the eastern US (ESO administration) where it is unlikely that BLM would have access to any other source of photography.

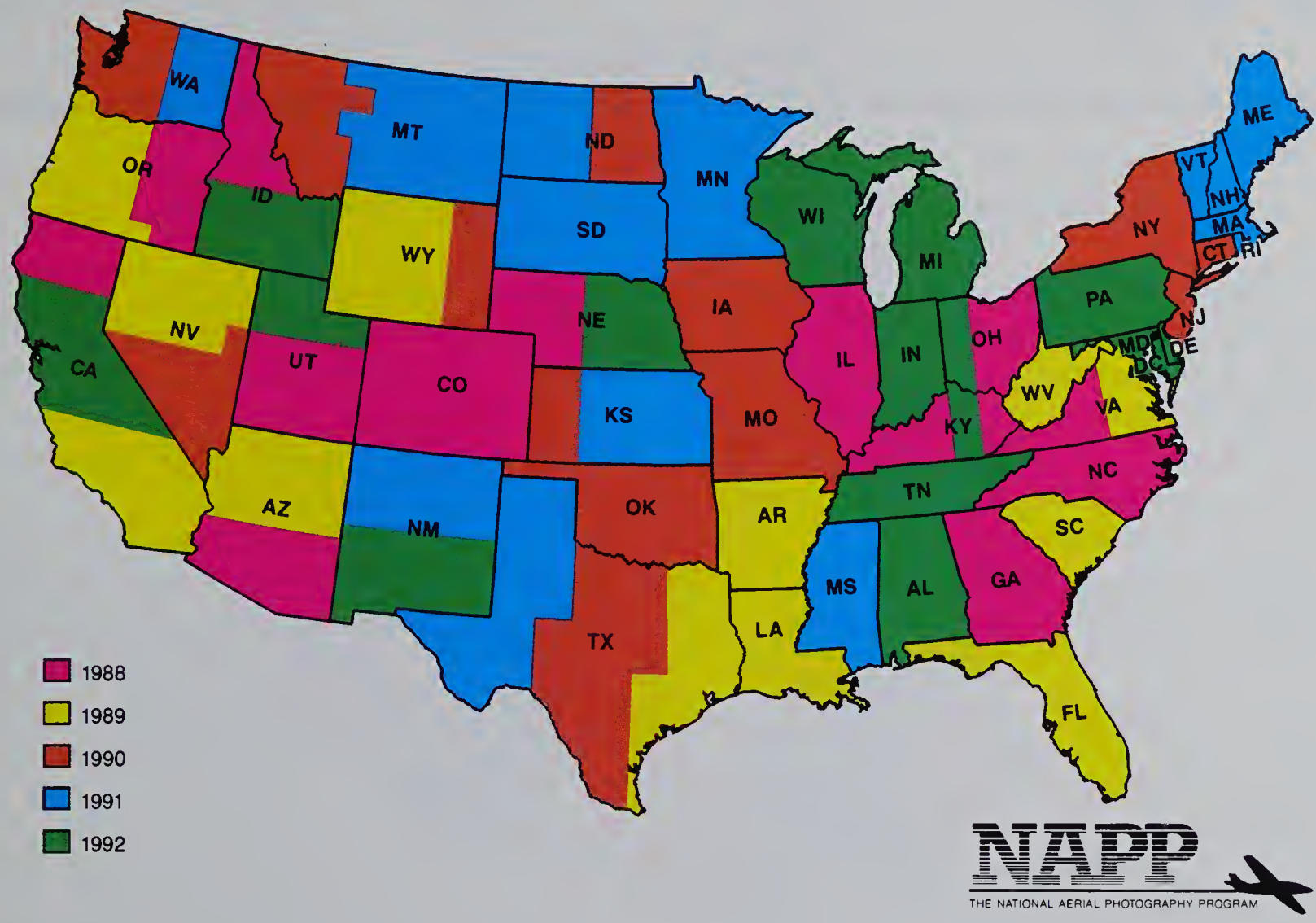
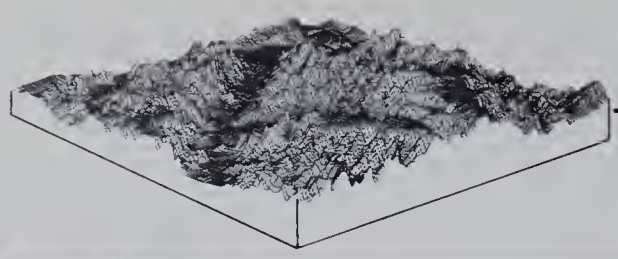


Figure 11
Multi-year NAPP Acquisition Plan



Appendix 6

BLM Cyclic Photography Acquisition Requirements

Much of the Bureau's aerial photography data base is 8-15 years old. It is rapidly becoming irrelevant to current land management situations. Due to the scheduling problems and photo scale deficiencies encountered with the NAPP photography, the states were requested during 1988 to carefully analyze their photo requirements and identify what they required to accomplish their missions. They were asked to consider the availability and utility of NAPP products.

Beginning in 1978, Alaska Federal and State agencies cooperated in the acquisition of black and white, and color infrared aerial photography in the Alaska High Altitude Program (AHAP). Since AHAP has been discontinued, the Alaska aerial photography requirements are included in the Bureau's proposed cyclic coverage.

The accompanying maps (BLM Cyclic Remote Sensing Acquisition Plan) for the 11 western states and Alaska have been consolidated from the state inputs. Requirements were formally transmitted by each State Office to the Service Center. All requirements are based on the input of the responding state based upon their local land management requirements and priorities.

Although there is some variation, dominant cyclic photography requirements consist of:

1) 1:24,000 scale,
2) natural color film, and
3) cycles ranging from 5-10 years based on local priorities.

Before initiation of a Bureauwide cyclic plan, the requirements will be coordinated with other major land management and mapping agencies (USFS, NPS, etc.) to search for common dates and project areas. This will undoubtedly lead to cooperative acquisition projects, thus reducing costs.

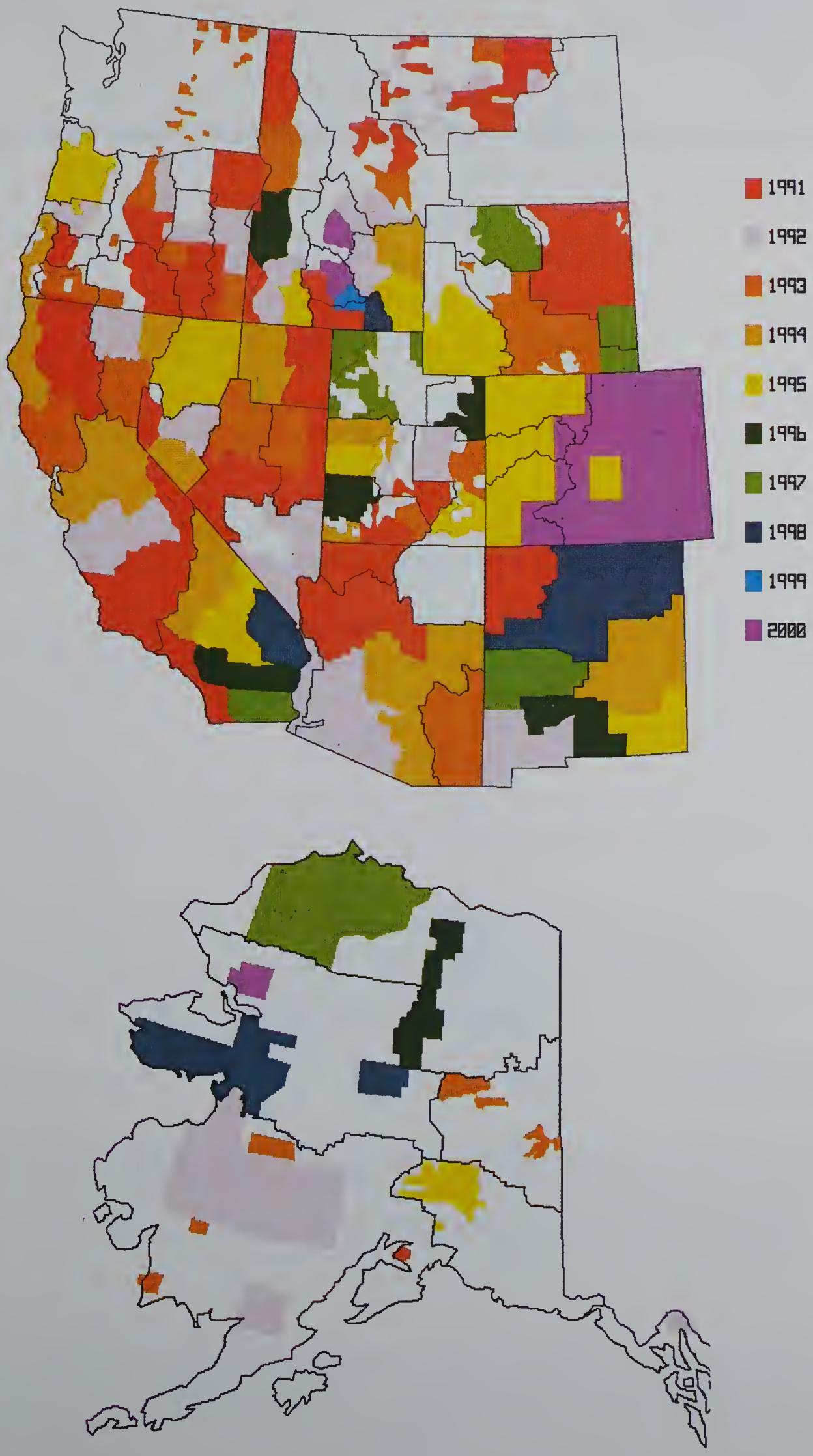
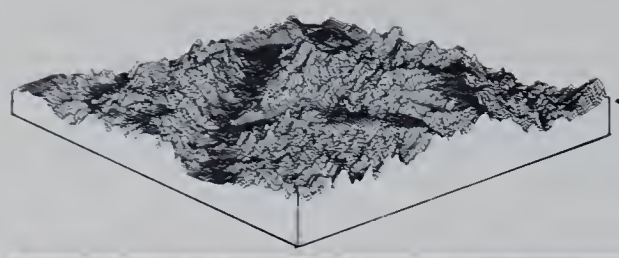


Figure 12

BLM Cyclic Aerial Photography Acquisition Plan



Appendix 7

Impacts of Automation and Modernization on the Bureau of Land Management

Final Report

April 1989

Hofman Subcommittee

Ron Hofman, CA (Chairman)
Pat Harvey, WO
Judith Herrington, SC
Ray Brubaker, WY
Doug Murphey, SC
Fran Cherry, NM
Mike Hengel, SC
Dennis Anderson, NV
John Moeller, WO
Brian Bernard, SC
Mike Dole, WO

BLM Field Committee

Problem Statement

Mapping sciences will have an increasingly important role in resource management as LIS/Modernization develops. Currently, the mapping sciences functions are highly fragmented and often not able to readily integrate their activities to provide the necessary support to LIS.

Discussion

Generally the mapping sciences umbrella includes remote sensing, aerial photography, photogrammetry, cartography, plat drafting, map preparation and graphics. Typically, States have individually distributed these functions among a variety of organizations. In the past, coordination among the different mapping sciences components has not been a primary need, thus it is often weak. Some functions have not been staffed or are seldom used. Currently, use and location of remote sensing and aerial photography are often dependent on the chance of resident skill some place in the organization. Plat drafting and cartography are rarely combined; graphics is located in a variety of organizations.

The development of automated means to portray land and resource features ties these functions together in a new way. They will be using common data bases, often building on a common digital base map that is tied to geographic coordinates. Work is underway to develop a means to convert satellite imagery data to the digital data used in the Geographic Information System applications. Satellite imagery and aerial photograpy are converging in their capability to obtain high resolution images. Both are seen as essential tools in the future management and maintenance of GIS produced resource data bases and mapping requirements. Plats will be developed using the same digital data for their base as GIS/LIS. Cartography and mapping will also utilize the GIS/LIS developed data bases and graphics capability for much of their work.

Automation appears to be a strong, new connection between the mapping sciences functions. Where operations have been primarily manual (plat drafting, mapping, and cartography), new skills will be required to successfully evolve to the coming automated environment. Coordination between the various functions will need to be excellent to ensure the most effective means of accomplishing a graphics task is selected. Cooperation in development, use, and management of common data bases will be essential.

There is also the possibility of increasing duplication and fragmentation of functions unless some positive efforts are made to integrate the mapping sciences functions more closely. Already, there are signs of potential new duplication of cartographic activities among GCDB and existing cartographic organizations.

All of this suggests that there may be a benefit from examining the mapping sciences functions to determine if the current organization of these functions is the most effective for the coming years.

Recommendations

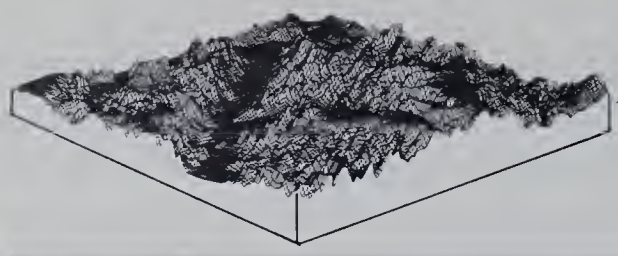
Analyze the mapping sciences functions, organization, staffing, and future mission including their role in GIS and other automation initiatives to determine the most effective organization for the future.

> Review the current and future work activities and tools; identify staffing and skills concerns.
>
> Determine what interrelationships between the different mapping sciences organizations and functions exist now and will be required in the future.
>
> Examine organizational configuration and make appropriate recommendations to support LIS/Modernization.

Coordinate findings with the Role/Function Study - Van Zanden.

Prepare appropriate amendments to the Bureau 1212 manual and Delegations of Authority.

(The above was extracted from page 19)



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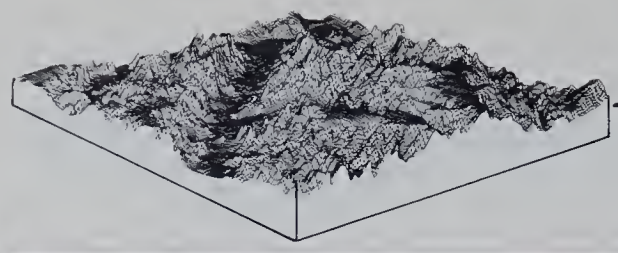

Appendix 9

Acronyms

AHAP	Alaska High Altitude Program
ALMRS	Automated Land and Minerals Records System
APD	Application Permit to Drill
ARD	Automated Resource Data
ARRS	Automated Resources Requirements Study
BLM	Bureau of Land Management
DEM	Digital Elevation Model
DLG	Digital Line Graphic
EA	Enviromental Assessment
EIS	Enviromental Impact Statement
ESO	Eastern States Office
GCDB	Geographic Coordinate Data Base
GIS	Geographic Information System
GPS	Global Positioning System
IDCCC	Interior Digital Cartographic Coordination Committee
IR	Infrared
K (100K)	1000 (1:100,000 scale)
LIS	Land Information System
MTP	Master Title Plat
NAPP	National Aerial Photography Program
NDCDB	National Digital Cartographic Data Base
NHAP	National High Altitude Photography Program
NMAS	National Map Accuracy Standards
NPS	National Park Service
OMB	Office of Management and Budget
OJT	On-the-Job-Training
PLSS	Public Land Survey System
RBD	Resource Base Data
RDBMS	Relational Data Base Management System
RMS	Resource Mapping Support
RMP	Resource Management Plan
ROW	Right-of-Way
SC	Service Center
SDMC	Spatial Data Management Committee
SO	State Office
TM	Thematic Mapper
USGS	United States Geological Survey
USFS	United States Forest Service
WODDB	Western Oregon Digital Data Base
3D	Three-dimensional

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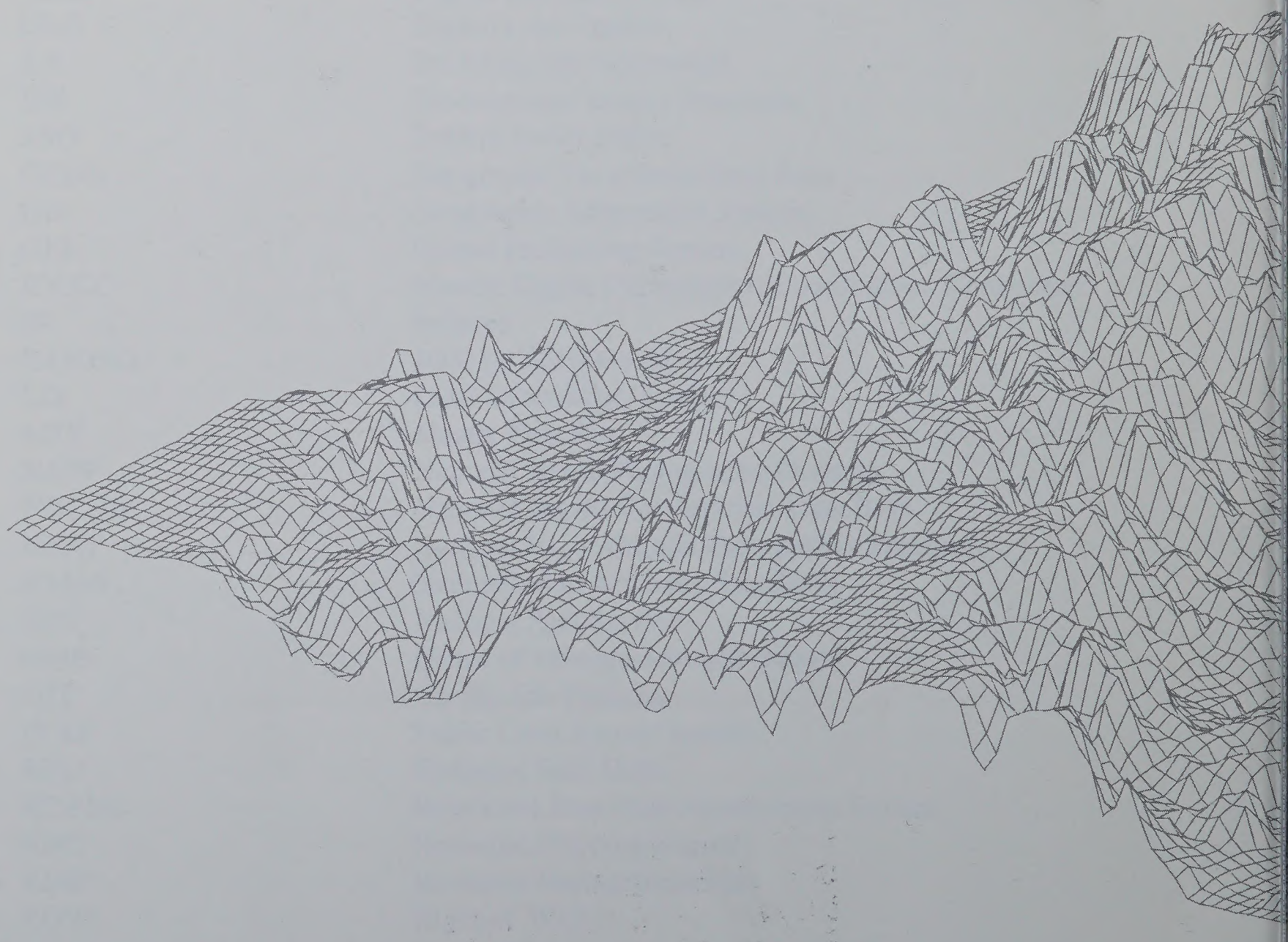

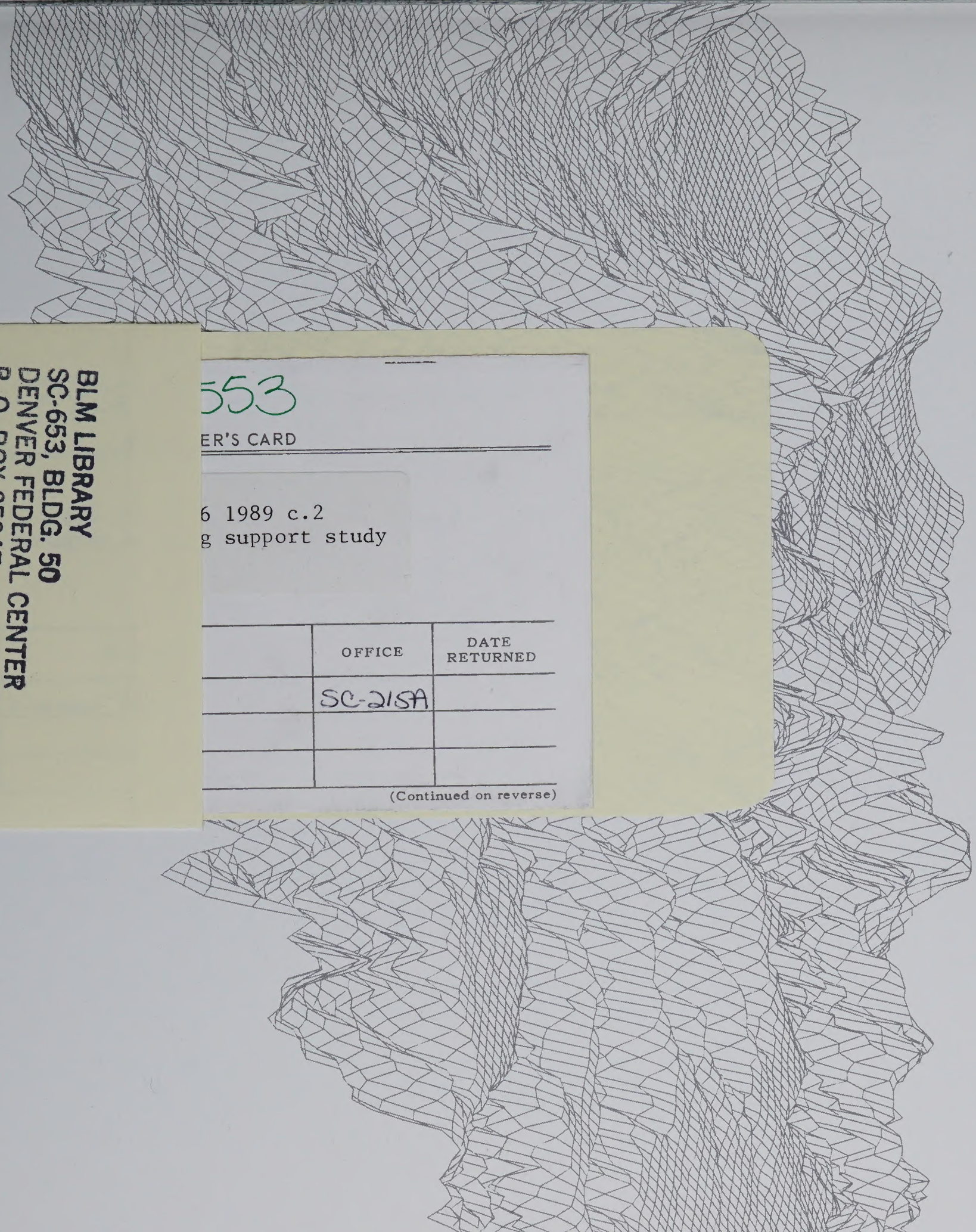

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